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ABSTRACT

This document is the second edition of the Annotated List of Laboratory Experiments in Chemistry first published in 1980. All entries in the Journal of Chemical Education describing laboratory experiments in chemistry or laboratory descriptions suitable for student experiments or projects, for the years 1957-1984 inclusive, have been listed and annotated. The list has been categorized into the seven principal fields of chemistry. These are: (1) analytical chemistry; (2) biochemistry; (3) inorganic chemistry; (4) organic chemistry; (5) physical chemistry; (6) polymer chemistry; and (7) radiochemistry. The level of the individual experiments are indicated, ranging from those that require no background in chemistry to those appropriate for advanced/specialized graduate courses. Additional keywords are used, as described in the accompanying glossary, to facilitate quick visual scanning of the list. (TW)

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**Annotated List of Laboratory
Experiments in Chemistry**
from
The Journal of Chemical Education
1957-1984

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Education Division

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Annotated List of Laboratory
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the Journal of Chemical Education

1957-1984

PROJECT CHEMLAB

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Annotated List of Laboratory Experiments in Chemistry
from the Journal of Chemical Education
Second Edition, 1957-1984

This list is a second edition, including additions and revisions, of the Annotated List of Laboratory Experiments in Chemistry published in 1980. All entries in the Journal of Chemical Education describing laboratory experiments in chemistry or laboratory descriptions suitable for student experiments or projects, in the years 1957-1984 inclusive, have been listed and annotated.

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For this format, the computer file has been organized by seven principal fields:

•ANAL	Analytical Chemistry
•BIOCHEM	Biochemistry
•INORG	Inorganic Chemistry
•ORG	Organic Chemistry
•PHYS	Physical Chemistry
•POLYMER	Polymer Chemistry
•RADIOCHEM	Radiochemistry

The level of the work is indicated as follows:

- 0 Requires no background in chemistry.
- 1 Appropriate for high school science or chemistry.
- 2 For general chemistry students.
- 3 For advanced first year and middle level undergraduate courses.
- 4 For advanced undergraduate or first year graduate courses.
- 5 For advanced graduate and specialized.

Additional KEYWORDS are used, as described in the accompanying Glossary to facilitate quick visual scanning of this list, as well as searching the computer file.

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KEYWORD GLOSSARY

Keyword	Definition
AA-FP	atomic absorption spectroscopy-flame photometry
ACBA	acid-base titration; acid-base reactions,theory
ACTIVITY	activity coefficients, ionic strength
ADDITION	an addition reaction
AFFC	affinity chromatography
ANAL	analytical chemistry, measurements
APPARATUS	a new apparatus
ASPIRIN	the Aspirin experiment. Preparation, properties or analysis of aspirin
ASSOC	association on the atomic-molecular level, incl. intermolecular H-bonding
AUTORAD	autoradiography
AVOGADRO	det'n or calculation of Avogadro's number
BACTERIA	bacterial preparations, microbial preparations
BIOCHEM	biochemistry, biochemical techniques
CALORIMETRY	calorimetry. See also HEAT, THERMO.
CARBENE	carbene reaction.
CATAL	catalysis, preparation, properties of catalysts
(CATALYSIS)	See CATAL
(CATALYST)	See CATAL
CHARGETRANS	charge transfer reactions
CHEM.ENG	chemical engineering emphasis.
CHIRAL	stereoisomers which have chiral properties; optical isomers. See also GEOM.
CHROMATOG	any kind of chromatography except AFFC,COLUMN,C, GELC, HPLC, PAPER, and TLC, which are indexed separately.
CLATH	clathrates, inclusion complexes
CLOCK	a clock reaction
CMC	critical micelle concentration.
COLLIG	colligative properties, except VAPORPRESS and CRYO, which are indexed separately.
COLLOID	colloidal state; prep'n, properties of colloids
COLOR	color; color-producing reactions; color-centers, dyes and dying; color photography. Colorimetric mthds, see COLORIM and UVIS (spectroscopy).
COLORIMETRY	See UVIS.
COLUMN	column chromatography
COMPLEX	complex compounds other than inclusion compounds (see CLATH) and coordination compounds of 1st row trans. metals (COORD).
COMPLEXIM	compleximetric methods. EDTA tit'ns are indexed under EDTA. See UVIS for spectroscopic mthds.
COMPUTER	applications of the computer in chemistry.
CONDUCT	conductivity.
(CONFORMERS)	see GEOM.
CONSUMERPROD	chemistry of consumer materials.
COORD	coordination compounds, coord'n polyhedra, especially first-row trans. metals. See also COMPLEX
CORROSION	corrosion chemistry
COURSE	a course of instruction. See also PROJ, INTEGR.
CRYO	cryogenics; freezing-point measurement; low temperature
CRYSTAL	crystalline state, crystal structure. For recrystallization, see SEPARATION

CYCLOADDITION	a cycloaddition reaction
DECAY	det'n of decay constant or half-life
DEMO	expt intended as a demo. Demonstration expts are indexed under the appropriate area keyword.
DENSITY	density measurements, density gradients. Optical dens., etc, not indexed under this keyword.
DIALYSIS	dialysis. See also MEMBRANE .
DIELS-ALDER	a Diels-Alder reaction. See also CYCLOADDITION .
DIFFUSION	the transport property. Diffusion in any state.
DIPOLE	dipole structure, dipole moments, etc.
DIST	distillation.
DISTRIB	solvent extraction, distribution between two (or more) phases, incl. counter current.
(DNA)	see NUCLACID
DRYLAB	a simulated experiment
DTA	differential thermal analysis, and similar techniques such as DSC,TGA, wt. loss on drying, etc.
(DYES)	see COLOR
(ECOLOGY)	see ENVIRON
EDTA	EDTA titration, EDTA properties, etc.
ELECTROANAL	electroanalytical measurements, e.g. coulometry, potentiometry, polarography. See also PH .
ELECTROCHEM	electrochemistry; electrochem techniques other than those indexed under ELECTROANAL .
ELECTRODE	preparation and/or use of any electrode except
ELECTROOPTIC	electrooptical methods. See also liquid crystal, technique. ion-selective electrodes. See IONSELECT .
ELECTROPHOR	electrophoresis, gel electrophoresis
ENVIRON	environmental chemistry
ENZYME	enzymes; enzyme kinetics
(EPR)	see ESR
ERROR	error analysis. See also STATISTICS . Errors in articles are indexed with the keyword MISTAKE .
ESR	electron spin resonance
EXCHANGE	exchange reactions, exchange rates
EXOBIO	chemical evolution; Miller exp'nt; exobiogenesis
EXPLOSION	An experiment which involves a legitimate explosion reaction, thus a hazard. For pyrotechnics, see MAGIC .
(EXTRACTION)	see DISTRIB
FASTREACTION	a fast reaction
FLASHPHOTOL	flash photolysis
FLUOR	fluorescence, fluorimetry.
FORENSIC	forensic chemistry
FREERAD	a free radical reaction or mechanism
FRIEDEL.CRAFTS	a Friedel-Crafts reaction
FUEL.CELL	use or construction of a fuel cell
GAS	gaseous state, gas law experiments, gas constant
GC	gas chromatography; gas-liquid chromatography, etc. HPLC is indexed separately.
GELC	gel chromatography
(GEL	see ELECTROPHOR
ELECTROPHORESIS)	
GEOM	geometric stereoisomers incl. conformers
GLASS	glass chemistry; glassy state; glass formation

GLOVEB	glovebag; glovebox; preparations that require an inert atmosphere.
GRAVIM	gravimetry; analytical balance
GRIGNARD	a Grignard reaction
(HALF-LIFE)	see DECAY
HANDICAPPED	designed for handicapped students
HAZARD	warning keyword. A hazard is involved that may or may not be highlighted in the article. All uses of this keyword explained in the abstracts.
HEAT	thermometry. Calorimetry and thermodynamics are indexed separately. See THERMO.
HETEROCYCLIC	heterocyclic chemistry
HISTORIC	repeats or modernizes a historic experiment.
HITEMP	high temperature techniques. This keyword should be taken as a warning that special hazards are involved and suitable precautions taken.
HPLC	high performance liquid chromatography; high performance reversed phase chromatogr., etc.
HPRESS	high pressure. WARNING: High pressure techniques involve hazards.
(HYDROLYSIS)	listed w. ACBA, KEQ
(IONIC STRENGTH)	see ACTIVITY
INORG	inorganic chemistry, techniques, materials
INSTR	an experiment for an instrumental analysis course
INTEGR	an integrated course of experimental work involving more than one field of chemistry
(IONIC STRENGTH)	see ACTIVITY.
IONSELECT	ion-selective electrodes, includes the glass electrode
IONX	ion-exchange techniques, materials
(INERT ATM)	see GLOVEB
IR	infra red spectroscopy, radiation
ISOMERS	structural isomers, isomerization. For stereoisomers, see CHIRAL or GEOM. Nuclear isomers are indexed under DECAY.
ISOTOPE	isotope effects; isotope dilution analysis
KEQ	equilibrium constant; formation constants, etc. Solubility product is indexed separately.
KIN	kinetics; rate of reaction
KSP	solubility product constant; see also SOLUB
LASER	lasers, techniques & materials
LIQUID	liquid state; liquid structure
LIQUID.CRYSTAL	self-explanatory.
LUMIN	luminescence; luminescence spectra
MACROCYCLE	macrocyclic cmpds or complexes; crown ethers
MAGIC	magic shows; fireworks
MAGNETIC	magnetism; Gouy balance. NMR, PMR indexed separately
MASSPEC	mass spectroscopy
MEMBRANE	preparation and properties of membranes; see also IONSELECT
MICELLE	formation & properties of micelles
MICROSCOPE	microscope; polarizing microscope
MISTAKE	calls attention to a serious error in an article, always explained in the abstract.
(MOLAR VOL)	see DENSITY
MOL.SPECT	molecular spectroscopy
MOLTENSALT	molten salt chemistry; techniques
MOSSBAUER	Mossbauer spectroscopy
NAME	a named reaction other than FRIEDEL.CRAFTS, DIELS. ALDER or GRIGNARD indexed separately
NATPROD	chemistry of natural products
NEUTRON	neutrons; neutron irradiation analysis

NMR	NMR and similar techniques (as PMR)
NONAQ	non-aqueous chemistry; non-aqueous titration
NOPROC	"no procedure" The experiment is described in some other fashion than the step by-step recipes used in lab manuals.
NUCL.ACID	nucleic acids incl. RNA, DNA.
OPTICAL	optics, optical instruments; overhead projector; cameras; TV sets. See also MICROSCOPE. Optical isomers are indexed as CHIRAL.
ORD	optical rotary dispersion
ORG	organic chemistry, materials & techniques
ORGANOMETAL	organometallics. Bioinorganics are accessed by calling BIO and INORG.
OSC.RXN	oscillating reaction
OSMOSIS	osmosis, osmometry
PAPERC	paper chromatography
PESTICIDES	pesticides
PH	pH chemistry; pH titrations; indicators
PHARM	pharmacological chemistry; pharmaceuticals
PHASE	phase diagrams; multiphase systems
PHEROMONES	pheromones
PHOSPHOR	phosphorescence; phosphors
PHOTO	chemistry of light; photolysis. FLASHPHOTOL is indexed separately. See also OPTICAL, LUMIN FLUOR, PHOSPHOR
PHOTORES	photoresist
PHYS	physical chemistry
(PMR)	see NMR
POLARIM	polarimetry
POLYMER	polymer chemistry; polymeric materials incl. oligomers
PORPHYRIN	chemistry of porphyrins and related substances
PREP	an inorganic, organic or biochemical preparation
PROJ	an experiment or set of experiments designed as or suitable for a class or individual project.
PROOF	a proof-of-structure experiment
PTC	phase transfer catalysis
(PYROTECHNICS)	See MAGIC, EXPLOSION.
QUAL	qualitative analysis
QUANT	quantitative techniques
QUANTUM	quantum mechanics; advanced spectroscopy
RADIOCHEM	radiochemistry; radiochemical techniques
RAMAN	Raman spectroscopy
REARRANGE	a rearrangement reaction
REDOX	reduction; oxidation; oxidation-reduction
REFRACT	refractometry
RESOLUTION	resolution of optical isomers
REVIEW	review; number of references given in abstract.
(RNA)	see NUCL.ACID
SAFETY	safety, new safe versions of old experiments.
SEMIQUANT	a semiquantitative technique
SEPARATION	separation techniques other than IONX, CHROMATOG, DISTRIB. Example: Distillation. See also TECHNIQUE.
SEQ	reaction sequence
SIMULATION	Computer simulated experiment
SOLAR	solar energy; see also ENVIRON
SOLID	solid state; solid structure
SOLUB	solubility; solution theory. Ksp: see KSP.
STATISTICS	statistics as applied to chemistry

(STEREISOMERS)	see CHIRAL or GEOM
STOICH	stoichiometry
(STRUCTURE)	For proof-of-structure, see PROOF. For structure of solids, etc., see the appropriate keyword. For structural isomers, see ISOMER.
SUBST.RXN	nucleophilic substitution reaction.
SURFACE	surface chemistry; surface tension; surface effects; surfactants
(SVEX)	see DISTRIB.
TAUTOMERS	tautomers, tautomerization
TCHROME	thermochromicity
TECHNIQUE	any technique not indexed separately. Example: steam distillation
THERMO	thermodynamics; thermodynamic functions. For thermal effects & thermometry, see HEAT. See also CALORIM, DTA.
(TGA)	see DTA
TITN	titration
TLC	tlc; thin layer chromatography
TRACER	tracer techniques
TRANSPORT	transport properties. DIFFUSION and VISC are indexed separately. See also ELECTRCHEM.
(TURBIDIM)	turbidimetry, indexed under UVIS.
UVIS	ultraviolet and/or visible spectroscopy; uv or visible radiation. See also PHOTO.
VACTEK	vacuum techniques; vacuum lines; gas-handling systems; low pressure
VAPORPRESS	vapor pressure; vapor state
VISC	viscometry
VITAMIN	vitamins.
WATERCHEM	chemistry of natural waters, as rain, river, tap, sea, etc.
XRAY	X-ray analysis; X-ray spectroscopy

*ANAL INORG IR QUANTUM 2

Infrared Spectrometry of Inorganic Salts: A General Chemistry Experiment
Ackermann, M. N.
J. Chem. Educ. 47,69 (1970)
KBr pellet technique (rapid). Molecular vibrations. 32 anhydrous binary salts. Requires an unknown.

*ANAL ELECTROCHEM 4

Electrodeposition of Silver and Copper Without the Use of Cyanide
Adams, R. J.; Blaedel, W. J.
J. Chem. Educ. 36,286 (1959)
Deposition from an ammoniacal solution onto a Pt gauze cathode. Caution: don't store ammoniacal silver solutions - explosion hazard.

*ANAL POLYMER CONSUMERPROD IR 3

The Vinyl Acetate Content of Packaging Film: A Quantitative Infrared Experiment
Allpress, K. N.; Cowell, B. J.; Herd, A. C.
J. Chem. Educ. 58,741 (1981)
The C-O stretching peak at 1030(cm⁻¹) used to measure vinyl acetate in ethylene vinyl acetate films. Samples of known vinyl acetate content required for calibration. Quant. IR based on industrial method. One hour. See Plummer, B. F., J. Chem. Ed. 61,439 (1984) for an interpretive note.

*ANAL ACBA APPARATUS REDOX TITN UVIS 4

Spectrophotometric Titrations for Students
Amdur, S.; Levene, W. J.
J. Chem. Educ. 51,136 (1974)
Rapid scanning spectrophotometer titration cell. Outlines for 6 titrations. Isosbestic point obs.

*ANAL ORG FRIEDEL-CRAFTS IR STATISTICS 4 HAZARD

Simplex Optimization of Yield in a Friedel-Crafts Alkylation. A Special Undergraduate Project in Analytical Chemistry.
Amenta, D. S.; Lamb, C. E.; Leary, J. J.
J. Chem. Educ. 56,557 (1979)
Optimizing the yield of sec-butylbenzene by simultaneously varying the molar ratio of 2-bromobutane to AlCl₃ and temperature. Analysis by quant. IR. HAZARD: benzene is carcinogenic.

*ANAL QUAL WATERCHEM 1

Water Analysis Experiment
Anderlick, B.
J. Chem. Educ. 49,749 (1972)
Qualitative tests for ions: calcium, iron(III), iron(II), mercury(II), magnesium, chloride, nitrate, phosphate.

*ANAL ORG CONSUMERPROD ENVIRON IR 2 3 HAZARD

A Practical Experiment for Determining a Pervasive, Persistent Pollutant
Anderson, C. P.; Saner, W. A.
J. Chem. Educ. 61,738 (1984)
PCBs are identified in water samples (must be spiked), gravel, sand, or cement. Extraction with methylene chloride and concentration is followed by isolation by TLC. Spots are scraped off and concentrated using Wick Sticks (TM). The dried tip is used to prepare an IR pellet. Methylene chloride is now a probable carcinogenic HAZARD, not described.

*ANAL HANDICAPPED 5

Chemical Instrumentation for the Visually Handicapped
Anderson, J. L.
J. Chem. Educ. 59,871 (1982)
Chemical instruments typically output an electrical signal transformed for visual perception. Methods for transforming such a signal into various formats that can be sensed by other than visual methods are described.

*ANAL INORG AA-FP COLUMNC 2 3

Mini-Column Ion-Exchange Separation and Atomic Absorption Quantitation of Nickel, Cobalt, and Iron: An undergraduate quantitative analysis exp't
Anderson, J. L.; Grohs, J.; Frick, D.
J. Chem. Educ. 57,521 (1980)
Groups of 5-10 for AA. Microliter samples make column chrom. fast. Possibly 4 hours. Very clear directions, including suggested point for interrupting experiment.

*ANAL INORG SEMIQUANT TECHNIQUE TLC 4

Slip Chromatography: A Semiquantitative TLC Technique
Andreasen, B.; Bohlbro, M.; Crossland, H.; Dennak, V.
J. Chem. Educ. 53,772 (1976)
Adsorbant = cellulose + carboxymethyl cellulose. Moving phase is a commercial buffer; method is for Pb⁺⁺; developer: diphenylcarbazide. calibration curve gives the length of Pb⁺⁺ trace vs. concn.

*ANAL ORG NATPROD TLC 2 3

Separation of Plant Pigments by Thin Layer Chromatography
Anwar, M. H.

J. Chem. Educ. 40,29 (1963)

Careful TLC (under nitrogen, in the dark) gives good results. Discussion of developing solvents. (Caution: a few, eg. CCl_4 , are carcinogenic.)

Prep'n of silicic acid strips using wheat starch as a binder described.

See also Rollins (1963).

*ANAL AA-FP DEMO ENVIRON UVIS VAPORPRESS 0 HAZARD

Visualization of the Atomic Absorption of Mercury Vapor by Use of a Fluorescent Screen

Argauer, R. J.; White, C. E.

J. Chem. Educ. 49,27 (1972)

Simple apparatus (UV source, fluorescent screen, squeeze bottle) to illustrate vapor pressure of Hg using UV "shadow" of mercury vapor. (Also demonstrates atomic absorption.) Hazard: Hg vapor (toxic)

*ANAL INORG QUAL 3 HAZARD

Precipitation of the Hydrogen Sulfide Group of Ions Using Thioacetamide
Armstrong, A. R.

J. Chem. Educ. 37,413 (1960)

Textbooks and literature sources vary considerably in their descriptions of the use of thioacetamide as a replacement for H_2S , and some seem not to know that the chemical has properties which are quite different from those of H_2S . A method is given for the sulfide pptn which will give complete pptn of the sulfide group in one treatment. HAZARD: thioacetamide is a carcinogen.

*ANAL SAFETY TECHNIQUE TLC 2 3

Use of Pseudophase TLC in Teaching Laboratories

Armstrong, D. W.; Bui, K. H.; Barry, R. M.

J. Chem. Educ. 61,457 (1984)

Aqueous surfactant solutions or cyclodextrins are used as developers in TLC to separate a wide variety of water-insoluble compounds. Students gain familiarity with micelles (refs.) as well as with TLC. Solutions are biodegradable, nonflammable, and of low toxicity.

*ANAL DISTRIB 3

A Laboratory Experiment with Dyes to Illustrate Countercurrent Distribution
Arreguin, B.; Padilla, J.; Herran, J.

J. Chem. Educ. 39,539 (1962)

Craig countercurrent distribution illustrated with two solvents (1-butanol, aq. sodium carbonate), two dyes (phenol red, bromocresol green), and a set of either 6 or 29 separatory funnels.

*ANAL APPARATUS DTA VACTEK 5

High Vacuum DTA-TGA Instrumentation for Air-Sensitive Compounds

Ashby, E. C.; Bousquet, P. C. J.; Etienne, J.

J. Chem. Educ. 52,618 (1975)

High-tech method used to study thermal decomposition of $\text{Mg}(\text{AlH}_4)_2$ and $\text{Mg}(\text{AlH}_4)_2 \cdot 2\text{THF}$.

*ANAL UVIS 2

Colorimetric Determination of Iron in Vitamin Supplement Tablets

A General Chemistry Experiment

Atkins, R. C.

J. Chem. Educ. 52,550 (1975)

Spec-20 calibration curve. Ortho-phenanthroline, hydroquinone.

*ANAL ORG QUAL TECHNIQUE 3

Use of the Oxygen Flask in Organic Qualitative Analysis

Ayres, D. C.; Dawson, B. E.

J. Chem. Educ. 42,270 (1965)

Combustion in oxygen followed by conventional AgX precipitation or other standard tests. Caution: possible explosive hazard.

*ANAL APPARATUS ELECTROCHEM KSP 2

Solubility Product Constants in a 4-inch by 4-inch by 1-inch Nutshell

Baca, G.; Lewis, D. A.

J. Chem. Educ. 60,762 (1983)

Construction of a waste-minimizing plexiglass unit to hold solutions and electrodes for measurement of 8 solubility products in a standard general chemistry experiment (Nernst eq., galvanic cells formed from pptn. of silver salts from analyzed mixtures).

*ANAL REDOX VITAMIN 2

The Determination of Ascorbic Acid: A Quantitative Analysis Experiment

Bailey, D. N.

J. Chem. Educ. 51,488 (1974)

Iodimetry. Unknowns or vitamin-C tablets.

*ANAL PHOTO TITN UVIS 2

The Analysis of a Silver-Copper Alloy

Baine, O.; Banewicz, J.

J. Chem. Educ. 34,297 (1957)

Home-made spectrophotometer incorporates a Weston model #594 Photronic photocell and a microammeter. Copper is det'd directly as the hydrated cation; silver by a modified Volhard titration.

*ANAL ACBA PHARM QUAL TITN 2

A Pharmaceutical Analysis Experiment for General Chemistry Laboratory

Baine, O.; Hicks, S.

J. Chem. Educ. 36,388 (1959)

Students identify active agent in a pharm. prepn. Tests for ascorbic acid, thiamine, phenobarbitol, quinidine, sulfathion. Quantitative analysis, all by acidimetry.

*ANAL INORG COORD IONX 3

Purifying and Identifying Transition Metal Complexes: An Experiment Using Cation Exchange Chromatography.

Balahura, R. J.; Lewis, N. A.

J. Chem. Educ. 53,324 (1976)

Cobalt(II) and (III) complexes. Details of column construction given.

*ANAL ELECTROANAL INSTR 4

A Cyclic Voltammetry Experiment for the Instrumental Analysis Laboratory

Baldwin, R. P.; Ravichandran, K.; Johnson, R. K.

J. Chem. Educ. 61,820 (1984)

Cyclic voltammetry requires only modest equipment: a \$500 CV unit and an X-Y recorder. This 2-part expt. introduces the technique of CV and its capabilities for kinetic and mechanistic analysis of electrode processes, including electrochemical reversibility and diffusion control, via the oxidations and subsequent reactions of p-phenylenediamine and thyronine.

*ANAL GC TECHNIQUE 3 4

A Combustion-Gas Chromatography Experiment

Bard, J. R.

J. Chem. Educ. 46,441 (1969)

Construction of simple combustion train. Measure CO₂ gc peak areas, calibrate.

*ANAL ORG CONSUMERPROD NOPROC PROJ 4

Quantitative Laboratory Experiments Based on Reactions of Cyclamates

Barnes, R. M.

J. Chem. Educ. 49,272 (1972)

Detailed presentation of student results. See especially for novel use of nitrates and nitrous acid. Methods include gc, ir, kin, uvis, electroanal.

*ANAL ELECTROCHEM IONSELECT 2 3

Analytical Determination of Fluoride Ion Using Gran's Semi-antilog Plot

Barnhard, R. J.

J. Chem. Educ. 60,679 (1983)

A well-planned series of demos and discussions designed to teach basic electrochemical principles from the ground up to the use of Gran's plots is described briefly. The analytical expt is not long, but requires care in technique and in eliminating complexing ions (Si+4, Al+3, Fe+3).

*ANAL INORG CATAL REDOX 3 4

Induced Redox Reactions: An Experiment for Introductory Analytical Laboratory

Baron, B. N.; Aikens, D. A.

J. Chem. Educ. 46,246 (1969)

Mn(II) to Mn(III) oxidation induced by oxidation of As(III) by Cr(III) in phosphoric acid.

*ANAL PHYS CATAL CLOCK KIN 2

Catalytic Determination of Trace Copper

Bartis, J. T.; Wiesenfeld, J. R.

J. Chem. Educ. 53,666 (1976)

The well-known Cu++ catalysis of the peroxydisulfate oxidation of iodide is adapted to the determination of trace copper. Calibration curve construction.

*ANAL 2

Analysis for Nitrite by Evolution of Nitrogen. A General Chemistry Laboratory Experiment

Bartlett, J. K.

J. Chem. Educ. 44,475 (1967)

Decomposition to nitrogen in presence of ammonium chloride. Ordinary lab glassware. Unknown sodium nitrite - sodium chloride mixture. Nitrogen gas collected over water.

*ANAL BIOCHEM HPLC INSTR SEPARATION 4

High Performance Liquid Chromatography of Urinary Compounds. An Undergraduate Experiment

Bastian, D. W.; Miller, R. L.; Halline, A. G.; Senfleber, F. C. Veening, H.

J. Chem. Educ. 54,766 (1977)

Five clinically important urinary compounds (uracil, uric acid, xanthine, allopurinol and nicotinamide) separated and determined by reversed-phase LC.

Separation is achieved by isocratic elution and UV detection.

*ANAL ACBA BIOCHEM CONSUMERPROD TITN 2

Pepsin and Antacid Therapy: A Dilemma

Batson, W. B.; Laswick, P. H.

J. Chem. Educ. 56,484 (1979)

Back-titration of an antacid-HCl solution to thymol blue. Criticizes other methods and indiscriminate antacid therapy.

*ANAL ORG QUAL 3 HAZARD

The Sodium Nitroprusside Reagent: A Classification Test for Aliphatic and Aryl Amines

Baumgarten, R. L.; Dougherty, C. M.; Nercessian, O.

J. Chem. Educ. 54,189 (1977)

Data on 29 aromatic amines. HAZARDS: dimethylsulfoxide absorbed thru skin; aryl amines are toxic, potential carcinogens.

*ANAL ORG HPLC PHARM QUAL 3

Qualitative Analysis of Analgesic Tablets

Beaver, R. W.; Bunch, J. E.; Jones, L. A.

J. Chem. Educ. 60,1000(1983)

A commercial C-18 reversed phase column is used; groups of students prepare solutions and develop a methanol-water composition suitable to separate standard compounds present in over-the counter analgesics. This analysis is well described in several references, including a Waters bulletin; if students are to experiment, do not give them refs. or the Waters bulletin.

*ANAL IONX QUAL 2

Elimination of Phosphates by Ion-Exchange in the Systematic Analysis of Cations

Bedetti, R.; Carunchio, V.; Tomassetti, M.

J. Chem. Educ. 53,122 (1976)

Cation exchange resin binds metals, not phosphate. Elution is followed by conventional analysis.

*ANAL ACBA APPARATUS ELECTROANAL NOPROC TITN UVIS 4

A Coulometric Titration Experiment: Simultaneous Potentiometric and Photometric Endpoint Detection

Beilby, A. L.; Landowski, C. A.

J. Chem. Educ. 47,238 (1970)

Special glassware and apparatus. Spec-20. Potentiometric and spectrometric determination of endpoint in titration of acid with electrolytically-generated hydroxyl ions.

*ANAL ELECTROANAL NOPROC PROJ 4

The Effect of Iodide Concentration on the Starch-Indicator End Point in the Coulometric Determination of As(III)

Bell, D. A.

J. Chem. Educ. 55,815 (1978)

Report of a class project. Endpoint was observed to be a gradually developing brown, hard to see and reproduce. Trouble located in that textbook-specified conc. of iodide was too high by a factor of 10.

*ANAL COLOR MICROSCOPE QUAL 2

Fusion Reactions Under the Microscope

Beneditti-Pichler, A. A.; Vikin, J.

J. Chem. Educ. 43,421 (1966)

A modification of the classical borax bead test uses electrically heated platinum wire under a microscope. Transition metals plus a few anions. Would make a good student project.

*ANAL ORG GC 3

The Separation and Identification of Straight Chain Hydrocarbons: An experiment using gas-liquid chromatography

Benson, G. A.

J. Chem. Educ. 59,344 (1982)

Straightforward. Dual column flame ionization. The idea is to give the students practical experience in dealing with a sample with many components.

*ANAL IONX QUAL 3

Cation Analysis by Ion Exchange for the Course in Qualitative Analysis

Berend, J.; Westcott, L.; Wiig, E.

J. Chem. Educ. 35,68 (1958)

Intended for sophomores in classical qualitative analysis course.

Modification of classical Group III analysis. Zn, Co, and Fe separated by use of an anion exchanger.

*ANAL INORG QUAL 2

The Detection of Acetate Ions in Qualitative Analysis
Berk, D.; Hecker, L.
J. Chem. Educ. 37,414 (1960)
A reliable test is described based on the fact that acetate ion pyrolyzes to carbonate.

*ANAL QUAL 1 2

Qualitative Determination of Nitrate with Triphenylbenzylphosphonium Chloride
Berry, D. A.; Cole, J. J.
J. Chem. Educ. 61,60 (1984)
TPBPC forms a white ppt. with nitrate. It is much more reliable than the brown ring test. Interfering anions are Br⁻, NO₂⁻, I⁻, MnO₄⁻. Qual scheme is included.

*ANAL INORG EDTA QUAL 2

A Qualitative Analysis Test For Chromium
Berthold, Sr. M. E.; Huchital, D.
J. Chem. Educ. 50,340 (1973)
Identification via EDTA complex.

*ANAL APPARATUS DISTRIB GC PROJ 3

Countercurrent Distribution with Simple Equipment
Bick, I. R. C.; Blackman, A. J.; Browne, E. J.
J. Chem. Educ. 58,814 (1981)
A ten stage homemade "Craig-type" apparatus (construction described) used to illustrate separation of benzophenone-diphenyl mixtures.
Solvents: petroleum ether, aqueous methanol. GC used for solute conc. analysis. Caution: flammable solvents.

*ANAL ORG TLC UVIS 4

Separation and Determination of Hydroxyacetophenones: An Experiment in Preparative TLC and UV Spectroscopy
Bick, I. R. C.; Blackman, A. J.; Browne, E. J.
J. Chem. Educ. 59,618 (1982)
Straightforward. Separation of the o-, m-, and p- isomers on silica TLC plates with fluorescent indicator. Moving phase is cyclohexane-isopropanol mixture. Isomers are recovered from the plate by scraping with a spatula and analyzed in ethanol solution by UV absorption spectroscopy.

*ANAL DISTRIB ENVIRON PESTICIDE TLC 3

TLC Analysis of Carbaryl Insecticide on Sprayed Foliage: A Student Experiment
Bidleman, T. F.; Rice, C. P.
J. Chem. Educ. 53,173 (1976)
Ambient leaves sprayed recently with carbaryl (= 1-naphthyl N-methylcarbamate) to control a gypsy moth infestation. Detailed procedure: silica plates; ethyl ether-hexane developer, visualization with NaOH spray. Caution: toxic compounds.

*ANAL HPLC PROJ 1 2

An Inexpensive Experiment for the Introduction of High Performance Liquid Chromatography
Bidlingmeyer, B. A.; Warren, F. V., Jr.
J. Chem. Educ. 61,716 (1984)
HPLC apparatus is simulated using two disposable syringes and a Sep-Pak (TM) cartridge. Highly colored substances such as food dyes allow for visual detection of separation. Complete, careful directions. Chromatographic parameters can be calculated. Designed for research/science fair project, but has other applications also.

*ANAL COLLIG CRYO PROJ TECHNIQUE 2 3

Tert-Butyl Alcohol as a Solvent for Cryoscopic Measurements
Bigelow, M. J.
J. Chem. Educ. 45,108 (1968)
A technique note; students could extend the work by finding anomalous cases.

*ANAL INSTR UVIS 4

Principles of Precision Spectrometry: An Advanced Undergraduate Experiment
Billmeyer, F. W., Jr.
J. Chem. Educ. 51,530 (1974)
Uses Beckman DK-2A or similar spectrometer to investigate instrument parameters.

*ANAL CONSUMERPROD ENVIRON FLUOR XRAY 3

X-Ray Fluorescence Determination of Lead in Gasoline
Bills, J. M.; Brier, K. S.; Danko, L. G.; Kristine, F. J.; Turco, S. J.; Zimmerman, K. S.; Divelbiss, P. M.; Tackett, S. L.;
J. Chem. Educ. 49,715 (1972)
Special plexiglas cell, Picker solid-state x-ray generator, radiation analyzer. Caution: Lead is an embryotoxin.

*ANAL IONSELECT IONX TITN 4

Experiments with the PVC Matrix Membrane Calcium Ion-Selective Electrode.
Birch, B. J.; Craggs, A.; Moody, G. J.; Thomas, J. D. R.
J. Chem. Educ. 55,740 (1978)
Extension of J. Chem. Ed. vol 51, 54 (1974) to complex formation equilibria.
Use of the electrode in titration of citrate, malate, malonate, and oxalate.

*ANAL GAS REDOX 1 2

A General Chemistry Experiment for the Determination of the Oxygen Content of Air
Birk, J. P.; McGrath, L.; Gunter, S. K.
J. Chem. Educ. 58,804 (1981)
Oxygen content determined by volume change of air sample trapped over water and exposed to steel wool soaked in 0.25M acetic acid. Method claimed to be safer than other methods found in intro. chem lab manuals, can complete in 2 hr.

*ANAL INORG PHYS CLOCK KIN NOPROC STOICH 2

Spot Plate Chemistry: General Chemistry Experiments in a Depression
Birk, J. P.; Ronan, T. H.
J. Chem. Educ. 54,328 (1977)
Experiments adapted to spot plate operation: Composition of insoluble salts by method of continuous variation: Colorimetric analysis, eg. lead, kinetics of formaldehyde clock. Caution: some of the reagents, eg. lead, are suspected toxins.

*ANAL INORG QUAL 3

A New Reagent for the Identification of Magnesium and Bismuth
Bishop, J. A.
J. Chem. Educ. 37,410 (1960)
Brominated tetraresorcinol pyromellitein forms a crimson lake with Mg^{++} , and a scarlet lake with $Bi(OH)_3$. Cu^{++} and Cd^{++} do not interfere.

*ANAL CONSUMERPROD UVIS 2

Analysis of Reducing Sugars in Breakfast Cereals and Other Foods
A General Chemistry Experiment.
Bitman, R.
J. Chem. Educ. 51,46 (1974)
3,5-Dinitrosalicylic acid reagent and standard glucose solutions are used to determine reducing carbohydrate after HCl hydrolysis in breakfast cereals. Does not determine sugar in cereals.

*ANAL ORG FORENSIC GC TECHNIQUE 3

The Recovery and Identification of Flammable Liquids in Suspected Arsons: An undergraduate organic experiment
Blackledge, R. D.
J. Chem. Educ. 51,549 (1974)
Procedure adapted from Florida Department of Law Enforcement involves steam distillation and GC.

*ANAL ORG COLUMNC TECHNIQUE TLC 3 HAZARD

"Dry-column" Chromatography: A new technique for the undergraduate laboratory
Bohen, J. M.; Joulie, M. M.; Kaplan, F. A.; Loev, B.
J. Chem. Educ. 50,367 (1973)
Separation of a dye mixture on a "dry column". Nylon column can be sectioned by cutting. Absorber = deactivated alumina. Moving phase is Benzene (HAZARD). Clear instructions and photographs.

*ANAL CONSUMERPROD HPLC VITAMIN 4

High Performance Liquid Chromatography of Vitamin A: A Quantitative Determination
Bohman, O.; Engdahl, K. A.; Johnsson, H.
J. Chem. Educ. 59,251 (1982)
Reverse-phase liquid chromatography used for food assay (infant formula). Expt was designed for a lab course in separations to follow organic chemistry, but is applicable to earlier lab courses. Complete analytical procedure.

*ANAL EDTA UVIS 4

Complexo-Turbidimetric Analysis of Cations in Solution
Bourque, C.; Mehra, M. C.
J. Chem. Educ. 54,769 (1977)
Titration of a series of $+2$, $+3$ cations by this method: the cation is reacted with excess EDTA. Sodium chromate solution is added and mixture is back-titrated with standard Pb^{++} solution. Endpoint is permanent yellow turbidity. Results are compared with those obtained using xylenol orange.

*ANAL BIOCHEM CONSUMERPROD FLUOR VITAMIN 3

Kinetic Fluorescence Experiment for the Determination of Thiamine
Bower, N.
J. Chem. Educ. 59,975 (1982)
One lab period. Suitable for large classes. Spectrofluorimetric analysis of vitamin tablets. Mercuric chloride is used to convert thiamine to thiachrome in a phosphate buffer. The rate of reaction and height of the fluorescence peak are both proportional to the thiamine concentration.

*ANAL PHYS ELECTROCHEM GRAVIM STOICH TITN 2

Mysterious Stoichiometry

Bowman, L. H.; Shull, C. M.

J. Chem. Educ. 52, 186 (1975)

0.3M KOH electrolyzed at 1 amp for 1 hour using Cr metal cathode, weighed stainless steel (inert) anode. Yellow solution resulting from electrolysis is acidified and titrated with standard Pb. Student is asked to find stoichiometric formula for the precipitate ($PbCrO_4$). Stony Brook suggestion: Bowman & Schull report titration endpoint unsatisfactory. Possible use of modified Job's method using height ppt. in centrifuge tube?

*ANAL INORG DISTRIB QUAL 3 HAZARD

Separation of Copper(II) From Cadmium(II) in Qualitative Analysis

Boyd, C. C.; Easley, W. K.

J. Chem. Educ. 35, 406 (1958)

Cu^{++} is extracted selectively by 8-hydroxyquinoline-chloroform solution.

HAZARD: both chloroform and 8-hydroxyquinoline are suspected carcinogens.

*ANAL INORG DISTRIB QUAL 3 HAZARD

The Separation of Arsenic in Qualitative Analysis

Boyd, C. C.; Easley, W. K.

J. Chem. Educ. 36, 384 (1959)

Short note. Arsenic is selectively extracted from HCl solution by a sol'n of catechol in benzene. HAZARDS: benzene, H_2S , arsenic.

*ANAL NMR 4

NMR Analysis of Water-Acetic Acid Solutions

Brabson, G. D.

J. Chem. Educ. 46, 754 (1969)

Proton NMR. Low resolution NMR spectrometer should be satisfactory.

*ANAL ELECTROANAL GLOVEB NONAQ TITN 4 HAZARD

The Simultaneous Potentiometric Titration of Cu and Fe in Non-Aqueous Media

Braun, R. D.

J. Chem. Educ. 53, 463 (1976)

Medium: dimethylformamide (DMF). Titrant: titanium (III) chloride in DMF.

Inert gas. HAZARD: titanium (III) chloride reacts vigorously with trace water evolving HCl gas.

*ANAL COMPUTER DRYLAB NOPROC 4

X-Ray Fluorescence Simulation

Breneman, G. L.

J. Chem. Educ. 56, 303 (1979)

Program in BASIC permits analysis of variables, unknowns (simulated).

*ANAL APPARATUS BIOCHEM ELECTROPHOR GELC 4 HAZARD

Disk Electrophoresis

Brewer, J. M.; Ashworth, R. B.

J. Chem. Educ. 46, 41 (1969)

Preparation of polyacrylamide gels (at different pH) in layers by photopolymerization. Use in separating proteins, nucleic acids only by reference. Apparatus for parallel of disk electrophoresis and also for prep. scale. HAZARD: acrylamide is toxic; benzene, a carcinogen.

*ANAL ORG COLOR TLC 3

Small-Scale Thin-Layer Chromatography: Experiments for teaching purposes

Brinkman, U. A. Th.; DeVries, G.

J. Chem. Educ. 49, 545 (1972)

Suggested expts include separation of dye mixtures, amino acids, inks, cations, etc. Novel developing chamber. Commercial plates.

*ANAL CHROMATOG IONX PAPERC QUAL TLC 4

Liquid Anion-Exchangers in Reversed-Phase Extraction Chromatography

Brinkman, U. A. Th.; DeVries, G.

J. Chem. Educ. 49, 244 (1972)

Eight liquid anion exchangers investigated. Silica gel or paper impregnated with the resins used to separate mixtures of metal ions in HCl solution. Visualization by spraying with organic reagents, eg., dithione. Rf vs. HCl conc. plots for 29 cations.

*ANAL INORG BIOCHEM COMPLEXIM PORPHYRIN UVIS 4

The Micro-Determination of Porphyrins: An Integrated Laboratory Experiment

Brisbin, D. A.; Asgill, J. O.

J. Chem. Educ. 51, 211 (1974)

Recording UVIS spectrophotometer. Porphyrin extracted from biological material (noproc) determined by spectrophotometric titration with standard solution of a transition metal (Mn, Ni, Cu, Zn) acetate; alternatively, analysis for transition metal concentration using standard protoporphyrin dimethyl ester.

*ANAL ORG PAPERC 3

Paper Chromatographic Separation of 2,4-Dinitrophenylhydrazones

Burnett, M. C.

J. Chem. Educ. 43, 385 (1966)

Easy separation of alkyl aldehyde and ketone, including two-dimensional for a few.

*ANAL INORG QUAL 3

Benzenoid Nitro-Compounds as Organic Reagents for Tin(II)

Burns, R. L.; Gruen, F. M.

J. Chem. Educ. 38, 410 (1961)

2% Naphthol Yellow S, 2% 2,4-dinitrophenol, and 2% meta-dinitrobenzene give characteristic colors with the Group II and III cations in the presence of KOH.

*ANAL GRAVIM TECHNIQUE TITN 2

Gravimetric Titrimetry: A neglected technique

Butler, E. A.; Swift, E. H.

J. Chem. Educ. 49, 425 (1972)

Use of a 2-oz. polyethylene washbottle as a gravimetric buret.

*ANAL ASPIRIN CONSUMERPROD HPLC INSTR 3 4

Two HPLC Experiments for Instrumental Analysis Laboratory

Byrd, J. E.

J. Chem. Educ. 56, 809 (1979)

Analysis of 1) components of APC tablets, 2) saccharin, sodium benzoate and caffeine in diet cola.

*ANAL INORG QUAL REDOX 4

Systematic Detection of Anions Through Their Parent Elements

Caldas, A.; Gentil, V.

J. Chem. Educ. 35, 545 (1958)

Research report. Development of a system of reactions to reduce anions to their elements, which are then determined by classical wet methods.

The scheme is (1) boil with alkali, (2) reduce with Al metal, (3) reduce with sodium formate, etc. Translated from the Spanish by Ralph E. Oesper.

The anions intended are coordination polyhedra with oxygen or fluorine as the ligands, eg. ClO_4^- .

*ANAL NATPROD TLC 1

An Investigation of Sebum and Other Facial Lipids

Calsin, D.; Trimler, W. A.

J. Chem. Educ. 50, 135 (1973)

Oils from skin taken up in ether, chromatographed on silica gel using petroleum ether: ether: acetic acid and with cholesterol, squalene, tristearin, oleic acid, cetyl palmitate standards.

*ANAL HPLC 4

Liquid Chromatographic Determination of Nitroanilines: An experiment for the quantitative analysis laboratory

Cantwell, F. F.; Brown, D. W.

J. Chem. Educ. 58, 820 (1981)

Rapid separation of o- and p-nitroanilines and 4-ethoxy-2-nitroaniline (Caution: toxic) using Amberlite XAD-2 resin and methanol at 200 psig as the moving phase. Teaching the handling of toxic materials is one objective of this experiment.

*ANAL ACBA ELECTROCHEM NOPROC 2

Conductance Experiments Utilizing a Wide-Range DC Meter

Carlton, T. S.

J. Chem. Educ. 44, 769 (1967)

Directions for construction of inexpensive meter, and suggestions for use in measuring ionic conductance and acid strength.

*ANAL COLORIMETRY COORD KEQ UVIS 4

Demonstrating Job's Method with Colorimeter or Spectrophotometer

Carmody, W. R.

J. Chem. Educ. 41, 615 (1964)

Job's method for $\text{FeCNS}(++)$ equilibrium - a low stability complex, for which this method was designed.

*ANAL CONSUMERPROD GC 2 3

Gas Chromatographic Analysis of Gasoline: A Laboratory Experiment

Cassidy, R. F.; Schuerch, C.

J. Chem. Educ. 53, 51 (1976)

Straightforward. Intended for upperclass non-majors.

0 *ANAL, UVIS 2

Colorimetric Analysis for Salicylate in Urine: An Experiment for Nursing Chemistry.

Cavanaugh, M. A.; Bambenek, M. A.

J. Chem. Educ. 55,464 (1978)

Standard salicylate samples and unknowns issued. Student is required to draw up standardization curve, at 535 nm. One 2-hr lab period.

*ANAL QUAL 2

Interference with the Molybdate Test for Phosphate in Qualitative Inorganic Analysis

Cavanaugh, M. A.; Pilger, R. C., Jr.

J. Chem. Educ. 56,342 (1979)

Two methods given for overcoming the interference of iodide in the pptn of ammonium phosphomolybdate.

*ANAL QUAL 3 HAZARD

Non-Cyanide Detection of Cadmium in the Presence of Copper

Chandra, R.

J. Chem. Educ. 38,409 (1961)

Six new methods using ordinary and organic reagents. HAZARD: Cadmium.

*ANAL QUAL 2 3

Detection of Phosphate in the Presence of Arsenate

Chandra, R.

J. Chem. Educ. 38,408 (1961)

Ammonium molybdate, sodium dithionate. Rapid, semimicro, qualitative.

*ANAL INORG QUAL 2 HAZARD

Rapid Detection of Cations of Copper Group

Chandra, R.

J. Chem. Educ. 38,413 (1961)

Short note suggests removal of Hg^{++} from qual. solutions by deposition on Al+3 foil; det'n of Bi^{+++} as the phosphate; pptn of Cu^{++} as the metal with dithionate ($S_2O_4^{=}$). HAZARD: procedure was devised before Cd^{++} , thioacetamide were known to be hazardous chemicals.

*ANAL QUAL 2

Detection of Barium, Strontium, and Calcium with Sodium Rhodizonate

Chandra, R.

J. Chem. Educ. 39,397 (1962)

Specific tests and scheme for mixtures.

*ANAL NOPROC QUAL 2 HAZARD

Specific Tests for Cations of Group II

Chandra, R.; Jindal, H. R.

J. Chem. Educ. 39,396 (1962)

Outline; most by reference. Some of the reagents suggested are now known to be severe health hazards.

*ANAL QUAL 2

Detection of Ferrocyanide, Ferricyanide, and Thiocyanate

Chandra, R.; Sharma, S. L.

J. Chem. Educ. 39,397 (1962)

Specific tests for differentiating.

*ANAL ASPIRIN CONSUMERPROD PHARM TLC 3 HAZARD

Thin-Layer Chromatography of Darvon Compound-65

Chasar, D. W.; Toth, G. B.

J. Chem. Educ. 51,487 (1974)

Silica gel, chloroform-methanol moving phase, visualization with fluorescein. Caffeine, aspirin standards. CAUTION: prescription drug HAZARD: chloroform (carcinogen).

*ANAL ORG PHARM TLC 3

TLC Separation of Drug Alkaloids

Chasar, D. W.; Toth, G. B.

J. Chem. Educ. 51,22 (1974)

Caffeine, quinine, brucine separated on silica gel plates; visualization by various methods, moving phase: methanol. CAUTION: the slurry used in preparing the plates uses a chloroform (carcinogen; toxic)/methanol mixture.

*ANAL INORG REDOX STOICH TITN 2

The Stoichiometry of an Oxidation-Reduction Reaction: An Elementary Chemistry Experiment.

Child, W. C., Jr.; Ramette, R. W.

J. Chem. Educ. 44,109 (1967)

Stoichiometry of reaction of hydroxylamine with iron(III) by titration of reduced iron with standard permanganate. See also Latimer, G. W., Jr., J. Chem. Ed., 44, 537 (1967).

*ANAL INORG QUAL 3

Toluene-3,4-dithiol and its Derivatives as Analytical Reagents: A New Approach to Qualitative Inorganic Analysis

Clark, R. E. D.; Neville, R. G.

J. Chem. Educ. 36,390 (1959)

Separations into groups I - IV by conventional methods is followed by use of toluene-3,4-dithiol as precipitating agent; it yields characteristically colored mercaptates. Catechol substitutes for ammonia in this procedure.

*ANAL AA-FP IONX 4 HAZARD

The Separation of a Sodium-Rubidium Mixture on an Ion Exchanger

A Laboratory Experiment

Coetzee, C. J.

J. Chem. Educ. 49,33 (1972)

Ammonium molybdophosphate exchanger. Column preparation procedure given. AA spectrometer or flame photometer. HAZARD: asbestos powder.

*ANAL ORG PHYS ELECTROANAL KIN 4

Amperometric Determination of Phenol Bromination Kinetics

Cohen, R.; Matzek, C.; Schlosser, S.; Huber, C. O.

J. Chem. Educ. 58,823 (1981)

Polarographic determination of base-catalyzed bromination of 2,6-dinitrophenol, m-nitrophenol, and p-nitrophenol. Bases used are pyridine, etc. Straightforward. Suitable for instrumental analysis or integrated course.

*ANAL GRAVIM KSP SOLUB 3

Solubility of Lead Bromide in Nitrate Media: A Study of Ionic Interactions

Cooper, J. N.

J. Chem. Educ. 49,282 (1972)

Lead chromate pptd from homogeneous solution (1), or chromate is generated by oxidation of Cr(III) with bromate (2), in gravimetric determination of lead as chromate.

*ANAL ELECTROANAL REDOX STOICH 3 HAZARD

The Oxidation of Hydrazine by Basic Iodine Solutions:

a Stoichiometric Study

Cooper, J. N.; Ramette, R. W.

J. Chem. Educ. 46,872 (1969)

Ratio of reactants and nature of products posed as a problem. Hydrazine standard, iodine by back potentiometric titration. Hydroxide by titration. Can be extended to analysis of gas product. Don't let student read it, spoils the fun.

HAZARD: Standardization of hydrazine with iodate uses ICl as a catalyst. ICl causes severe burns.

*ANAL PHYS COMPUTER INSTR 4

Detection of Overflow in Signal Averaging: A Simple Experiment in Digital Logic

Cooper, J. W.

J. Chem. Educ. 59,427 (1982)

Simple experiment for teaching modern electronics, e.g. in an instrumental analysis or physical chemistry course.

*ANAL INSTR MOL.SPECT 5

Determination of the Performance Parameters of a Spectrophotometer:

An Advanced Analytical Experiment.

Cope, V. W.

J. Chem. Educ. 55,680 (1978)

Problem posed is the selection of a spectrophotometer. Determination of baseline linearity, absorbance stability with time, signal/noise ratio, resolution, etc.

*ANAL CONSUMERPROD FLUOR 2 3

Simple Fluorimetric Analysis of Glycine in Dietetic Beverages

A Student Experiment

Coppola, E. D.; Hanna, J. G.

J. Chem. Educ. 53,322 (1976)

Perkin-Elmer #203 Spectrofluorimeter used. Employs a new reagent, 4-phenylspiro(furan-2(3H),1'-phthalan)-3,3'-dione (fluorescamine), for determination of primary amines and amino acids at picomole levels.

*ANAL ORG ASPIRIN DISTRIB TLC 2 3 HAZARD

Thin Layer Chromatographic Separation of Common Analgesics: A Consumer Experiment.

Cormier, R. A.; Hudson, W. B.; Siegel, J. A.

J. Chem. Educ. 56,180 (1979)

Initial extraction with chloroform (HAZARD - carcinogen). Silica plates with fluorescent indicator. Moving phase: 1-butyl alcohol/methyl 2-butyl ketone/ethyl acetate. Visualization by uv light. Rf values given for 5 candidate compounds.

*ANAL ELECTROANAL INSTR 4

Qualitative and Quantitative Analysis Using a Rapid-Scanning Polarograph: An Experiment for Undergraduate Instrumental Analysis.

Cotter, R. J.

J. Chem. Educ. 54,457 (1977)

Instrument modifications, then straightforward. Co++, Cd++, Zn++, etc. in aqueous solution.

*ANAL/ORG GC NATPROD 3

The Identification of Vegetable Oils - A Gas Chromatographic Experiment
Cover, R. E.

J. Chem. Educ. 45,120 (1968)

Unkn. vegetable oil saponified and injected as methyl esters. Flame ionization detector and thermal conductivity detector. Methylating agents are NaOCH₃ and BF₃.

*ANAL APPARATUS DEMO GC 3 HAZARD

A Gas Chromatography Demonstration Apparatus

Cowan, P. J.; Sugihara, J. M.

J. Chem. Educ. 36,246 (1959)

Relatively simple apparatus for separating various organics. Hydrogen flow (pressure checked by oil manometer) thru column packed with Tide detergent powder or dinonyl phthalate on firebrick. Sample (10-20 microliters) thru serum cap, elution time by change in hydrogen flame characteristics. HAZARD: hydrogen forms explosive mixtures with air. Otherwise suitable for project, but some vaporized compounds are hazardous.

*ANAL EDTA PHARM 3

Preparation of Variable Purity Samples for Use in Disodium EDTA-ate Volumetric Analysis.

Cox, P. J.

J. Chem. Educ. 54,717 (1977)

Author teaches analytical chemistry to pharmacy students. In analyzing commercial samples, students may read the analysis from the container, and realize what the results of their analysis should be. To avoid this bias, methods for preparing similar unknowns (ointments, powders, etc.) are described in this article.

*ANAL ELECTRODE IONSELECT IONX 4

PVC Matrix Membrane Ion-Selective Electrodes; Construction and Laboratory Experiments.

Craggs, A.; Moody, G. J.; Thomas, J. R. D.

J. Chem. Educ. 51,541 (1974)

Calibration, determinations with calcium/nitrate ion-selective electrodes. Uses liquid ion exchangers, polyvinyl chloride powder in the construction.

*ANAL ELECTROPHOR TECHNIQUE TLC 4 5 HAZARD

Electrophoresis Using Thin Layer Materials

Criddle, W. J.; Moody, G. J.; Thomas, J. D. R.

J. Chem. Educ. 41,609 (1964)

Silica plates. Organic dye samples. Refer earlier publications for electrophoresis. Uses high voltage power supply (hazard), borax electrolyte.

*ANAL ENVIRON PREP UVIS WATERCHEM 3 HAZARD

The Determination of Anionic Surfactants in Natural and Waste Waters

Crisp, P. T.; Eckert, J. M.; Gibson, N. A.

J. Chem. Educ. 60,236 (1983)

Anion surfactants are extracted as an ion-association compound with diaquabis(ethylenediamine)copper(II) cation and analyzed by visible spectrophotometry using 3-propyl-5-hydroxy-5-D-arabinotetrahydroxybutyl-3-thiazolidine-2-thione (prep. given is simple but (HAZARD) carbon disulfide is toxic and very flammable) as the color-developing reagent.

*ANAL PAPERC 2 3

Paper Chromatography of Carbohydrates

Croft, L. R.; Haghighi, S.

J. Chem. Educ. 54,112 (1977)

Chem. Ed. Compact. Solvent: 1-butanol-HOAc-water. Visualization by 1% NaOH in 60% ethanol-water. Author says carbohydrates appear as yellow or light brown spots. No data.

*ANAL GRAVIM NOPROC QUANT TITN 2

An Introductory Quantitative Laboratory Exercise

Crossfield, A. J.

J. Chem. Educ. 54,190 (1977)

Short note describes successful classroom use of analysis of (barium chloride dihydrate/ NaCl) mixtures for water (loss on heating) and total chloride (Mohr method) as introductory experiment.

*ANAL PHYS STATISTICS 3

Evaluation of Experimental Data: A Laboratory Exercise

Cunningham, C. C.; Brown, G. R.; St Pierre, L. E. E.

J. Chem. Educ. 58,509 (1981)

First lab for p-chem. Experimental 2 hrs. Density of marbles, radius of capillary bore. Histograms for real variations vs. random errors. Good emphasis on assumptions. Would lend itself to BASIC programming by beginners.

***ANAL APPARATUS ERROR STATISTICS 3**

Data Correlation Experiment

Cunning, J. D.; Burnet, G., Jr.; Levenspeil, O.
J. Chem. Educ. 41,35 (1964)

Random error simulator produces data to fit linear and higher order polynomials. Circuit given. Simulate least squares, linear regression analysis.

***ANAL CONSUMERPROD UVIS 2**

A Spectrophotometric Determination of Fluoride Adapted for the Freshman Laboratory

Daines, T. L.; Morse, K. W.
J. Chem. Educ. 51,680 (1974)

Sodium 2-parasulfophenylazo-1,6-dihydroxy-3,6-naphthalene disulfonate, zirconyl chloride, toothpaste unknown

CAUTION: fluorides - toxic.

***ANAL COLUMNC UVIS 3 HAZARD**

An Undergraduate Column Chromatography Experiment

Danot, M.; Nahmias, S.; Zoller, U.

J. Chem. Educ. 61,1019(1984)

Separation of a mixture of iodine, methylene blue, and benzoic acid (optional) illustrates chromatographic theory, using dry column technique. Students graph component conc. vs. volume of fraction leaving column and determine recovery yield of methylene blue by colorimetry. CCl₄ and now methylene chloride are unstated carcinogenic HAZARDS.

***ANAL CATAL REDOX TITN 3**

An Improved Method in the Redox Titration of Oxalic Acid by Permanganate

Datta, M.; Ameta, S. C.; Pande, P. N.; Gupta, H. L.; Bokadia, M. M.
J. Chem. Educ. 56,659 (1979)

Ascorbic acid catalyzes this reaction, so titration can be carried out without heating. Empirical.

***ANAL SEMIQUANT UVIS 1 2**

Evolution of an Experiment (from Moles Per Liter Squared to Gaseous CaCl₂)

Dauphinee, G. A.
J. Chem. Educ. 56,116 (1979)

Analysis of trace iron in reagent-grade calcium hydroxide by SCN⁻-colorimetry, leads to apparently contradictory results with salicylic acid test, for iron III. Good: do not let the students read it.

***ANAL CONSUMERPROD ELECTROANAL 4 HAZARD**

Determination of Pb and Cd in Pottery Using Anodic Stripping Voltammetry.

Deanhardt, M. L.; Dillard, J. W.; Hanck, K. W.; Switzer, W. L.
J. Chem. Educ. 54,55 (1977)

FDA leaching process given. Polarograph, recorder, hanging mercury drop electrode. Hazards: Pb, Cd.

***ANAL INORG NOPROC QUAL 2**

First Semester Qualitative Analysis

DeLap, J. H.

J. Chem. Educ. 46,837 (1969)

Students devise qual. schemes for four groups (three cation, one anion) and then do unknowns.

***ANAL ORG PHYS BIOCHEM IONSELECT KIN 4 HAZARD**

Kinetic Studies with Ion Selective Electrodes: Determination of Creatinine in Urine with a Picrate Ion Selective Electrode; A Laboratory Experiment

Diamandis, E. P.; Koupparis, M. A.; Hadjiioannou, T. P.
J. Chem. Educ. 60,74 (1983)

Detailed report of use of picrate ion sensitive electrode (construction, which appears not to be easy, by ref.) in the detn. of creatinine by formation of the 1:1 red complex with picrate ion in alkaline solution. Includes prepn. of calibration curve and kinetic studies of the complex-forming reaction. Method of prep of the standard picrate solution is HAZARDOUS. Air-dried picric acid is HIGHLY SHOCK-SENSITIVE (not noted in paper).

***ANAL UVIS 1 2**

Spectrophotometry: Mechanics and Measurement

Diehl-Jones, S. M.

J. Chem. Educ. 61,255 (1984)

In this open-ended experiment designed for high school, students become acquainted with the components of a spectrophotometer, use Beer's law in several ways, and compare the limits of detection of eye vs. instrument, using a colored "unknown".

***ANAL COLUMNC NATPROD TLC UVIS 1 2 HAZARD**

Chlorophyll Separation and Spectral Identification

Diehl-Jones, S. M.

J. Chem. Educ. 61,454 (1984)

Photosynthetic pigments are extracted from spinach, chromatographed using both column and tlc and identified by absorption spectra. HAZARDS associated with organic solvents are clearly stated. Not new, but designed for high school (research oriented, several labs) and useful in college courses also.

***ANAL DISTRIB UVIS 3 HAZARD**

The Effect of pH on the Extraction of Copper Oxinate into Chloroform.
Ditts, R. V.
J. Chem. Educ. 47,661 (1970)
Copper-8-Hydroxyquinoline complex extracted; determined by colorimetry.
Requires accurate pH meter. Spec-20.
HAZARD: CHCl₃ is a carcinogen

***ANAL ENVIRON GC 3**

Hydrocarbons in Ambient Air.
Dinardi, S. R.; Briggs, E. S.
J. Chem. Educ. 52,811 (1975)
Calibration curve from pure methane mixtures with pure air, direct injection gives 0.5 - 5 ppm range. Note that concentration by absorption techniques are used for analysis of lower concentrations.
Flame ionization detection, gas sampling valve, flow meter, 100 ml gas syringe. Planimeter (or integrator).

***ANAL COMPUTER ELECTROANAL TITN 2**

A Computerized Soda Ash Experiment for First Year College Chemistry
Dinga, G. P.
J. Chem. Educ. 46,60 (1969)
Double indicator titration, potentiometric titration, computer program (on request) for first and second deriv. plots.

***ANAL INORG GRAVIM STOICH 1 2**

The Stoichiometry of Sulfides: Experiments for the introductory laboratory
Dingley, D.; Barnard, W. M.
J. Chem. Educ. 44,693 (1967)
Direct combination of lead and nickel with sulfur used to demonstrate law of constant proportions. Unreacted sulfur is simply boiled off.

***ANAL TLC UVIS 3**

Isolation, Separation, and Identification of Synthetic Food Colors
Dixon, E. A.; Renyk, G.
J. Chem. Educ. 59,67 (1982)
Analysis of water-extractable dyes in foods by UV-vis. Silica gel plates. Sources, and R_f values and absorptions for many candidates. Recording UV.

***ANAL ACBA COMPUTER DEMO ELECTROANAL TITN 3**

Automatic and Microcomputer-controlled Potentiometric Titrimetry.
Doane, L. M.; Stock, J. T.; Stuart, J. D.
J. Chem. Educ. 56,415 (1979)
Microcomputer control of flow rate and cutoff in potentiometric titration. No hardware details. Program in BASIC available from authors.

***ANAL DEMO TLC 2**

TLC Separation of Ink Pigments
Druding, L. F.
J. Chem. Educ. 40,536 (1963)
Simple experiment to demonstrate TLC when it was a new technique. On layer of silica gel on glass plate, moving phase ethanol.

***ANAL ORG QUAL 3**

Identification of Carboxylic Acids
Duff, J. G.; Yung, D. K.; Brenner, R. J.; Wilson, B. J.; Racz, W. J.
J. Chem. Educ. 46,388 (1969)
Piperazinium salts of unknown carboxylic acids prepared (table).
Data collection (extensive).

***ANAL APPARATUS FLUOR UVIS 3**

A Laboratory Experiment in Fluorescence Using the Spectronic 20.
Duncan, R. L.; Kirkpatrick, J. W.; Neas, R. E.
J. Chem. Educ. 49,550 (1972)
Requires spectrophotometer modification - filters. Prep'n of calibration curve from quinine sulfate/dil. H₂SO₄, and analysis of a constructed unknown. Within capacity of most univ. freshmen. Caution: uv lamp.

***ANAL QUAL 3 HAZARD**

Non-cyanide Detection of Cadmium
Dutta, R. L.; Choudhury, S. D.
J. Chem. Educ. 40,414 (1963)
Biguanide acid sulfate; N-benzoylphenylhydroxylamine.
HAZARD: Cadmium is toxic.

*ANAL DIFFUSION SEMIQUANT 2

Quantitative Analysis of Silver-Copper Alloys by Diffusion in Gelatin Eby, Sr. D.

J. Chem. Educ. 39,406 (1962)

Low chloride gelatin. Conc. of silver ions and of copper ions (latter differentiated by oxine or ferrocyanide reaction) is proportional to diameter of diffusion "zone". Not clear why this is a linear relation. Not very accurate.

*ANAL ACBA SOLUB TITN 2

The Solubility Curve of Borax: A student laboratory experiment Eddy, R. D.

J. Chem. Educ. 35,364 (1958)

A "first-titration" experiment. Saturated borax solutions are diluted and titrated with standard 0.25M HCl. This is not an acid-base reaction in the usual sense, but a displacement reaction in which the weak boric acid is displaced by the stronger HCl. $\text{Na}_2\text{B}_4\text{O}_7 + 2\text{HCl} + 5\text{H}_2\text{O}$ yields $2\text{NaCl} + 4\text{HBO}_3$. Indicator: methyl red.

*ANAL INORG QUAL REDOX TECHNIQUE 3

Applications of Sodium-Lead Alloy in Qualitative Inorganic Analysis

Edge, R. A.; Fowles, G. W. A.

J. Chem. Educ. 42,436 (1965)

Data collection. Color-reaction, etc. in acid and basic media.

*ANAL ENVIRON 1

Soil Analysis for High School Chemistry Students

Eisenmann, M. A.

J. Chem. Educ. 57,897 (1980)

End of 1st year high school. Soil tested qualitatively for CO_3^{2-} , NO_3^- - $\text{Fe}^{+2,+3}$, pH. Practical applic. of acid/base, redox, solubility. Fits well with experiments in Modern Chemistry, Metcalfe et al. 50 minutes, but probably tight. Crause, W.C., J. Chem. Ed., 61, 268(1984) points out some significant errors in the discussion.

*ANAL CONSUMERPROD TLC 1

Separation of Paprika Pigments - An Introductory TLC Experiment

Elder, J. W.; Abbruzzese, J.; Murray, J.; Zielski, M.

J. Chem. Educ. 53,43 (1976)

Paprika, cayenne, chili pepper, etc. Extracted with dichloromethane. TLC or silica gel fluorescent indicator, with CH_2Cl_2 as moving phase. We've had a little trouble with it at Stony Brook, but it does work. Caution: CH_2Cl_2 should be used in the hood.

*ANAL AA-FP CONSUMERPROD IR MASSPEC NMR UVIS 4

Spectroscopic Techniques in the Chemistry Laboratory: A science enrichment course for high school teachers.

Emert, J.; Zeldil, M.

J. Chem. Educ. 57,451 (1980)

Videotapes of projects available from Polytechnic Institute of NY.

Projects: det'n of Pb in roadside dirt, efficiency of commercial sunscreens, keto-enol tautomerism, det'n of structural isomers, relative abundance of tin isotopes. Continuing education for in-service HS teachers.

*ANAL ORG ELECTROANAL TITN 3

Coulometric Titration of Cyclohexene with Bromine

Evans, D. H.

J. Chem. Educ. 45,88 (1968)

Bromine generated by constant current electrolysis of bromide. End point detected amperometrically. Useful for trace unsaturates determination.

*ANAL GC IR NMR 3 HAZARD

Instrumental Techniques Demonstrated by Analysis of a Reaction Mixture

Fairless, B. J.; Dunn, H. E.; Foster, D. O.

J. Chem. Educ. 48,827 (1971)

A reaction mixture of alkyl aryl amines is analyzed by gc (analytical and preparative) and separated products by ir, nmr. HAZARD: arylamines are suspected carcinogens.

*ANAL ELECTROANAL QUAL 1

Electrographic Analysis of the Iron Triad: A general chemistry experiment Feinstein, H. I.

J. Chem. Educ. 49,268 (1972)

1.5 volt dry cell, electro-spot tests; color-developing reagents are potassium ferricyanide, potassium thiocyanate, dimethylglyoxime.

*ANAL ACBA ELECTROANAL REDOX 3 HAZARD

Simple Experiments in Amperometry: Determination of Acids and Oxidizing Agents

Feldman, F. J.

J. Chem. Educ. 43,378 (1966)

Standardize with addition of 0.01 N perchloric acid to standard iodide-iodate solutions. Uses a microammeter, potentiometer, Pt electrodes, mag. stirrer. Hazard: HClO_4 is a storage hazard.

*ANAL QUAL 1

The Identity of Chemical Substances: A First Laboratory Experiment for Elementary Chemistry Students.

Fernandez, J. E.

J. Chem. Educ. 53,718 (1976)

Students are given two test tubes each containing a solid and asked to say if the two solids are the same or different. (e.g., NaCl and sucrose crystals). Study questions given. High School Forum note.

*ANAL NOPROC QUAL 1

The Identity of Chemical Substances: A first laboratory experiment for elementary chemistry students

Fernandez, J. E.

J. Chem. Educ. 52,726 (1975)

A "same or different?" experiment described. Study questions given.

*ANAL ASPIRIN CONSUMERPROD INSTR UVIS 3

An Experiment for Instrumental Analysis: determination of aspirin by ultraviolet absorption

Fernandez, L. T.; Klappmeier, F. H.

J. Chem. Educ. 55,266 (1978)

Aspirin is determined in commercial products by hydrolyzing to salicylic acid. This compound has an absorption peak in the near UV allowing calibration with standard salicylic acid solutions.

*ANAL INORG DISTRIB QUAL 3

Improved Confirmatory Test for Chromium

Fernand, E. F., Jr.

J. Chem. Educ. 37,411 (1960)

CrO₅ extracted with ethylene glycol mono-butyl ether. Bibliographers note: the extracted species is said to be CrO₅ four times in this article.

*ANAL FLUOR UVIS 3 HAZARD

Fluorescence Determination of Aspirin in APC Tablets

Fligen, R. A.; Plude, J. L.; Seitz, W. R.

J. Chem. Educ. 56,658 (1979)

As part of determination of aspirin, phenacetin, caffeine in tablets.

this is a modification to determine aspirin by fluorescence analysis.

HAZARD: chloroform, used in extraction, is carcinogenic; substitute.

*ANAL INORG ORG DISTRIB QUAL 3 HAZARD

The Use of N-Chlorosuccinimide for Identification of Bromide and Iodide Ions Filler, R.

J. Chem. Educ. 35,412 (1958)

N-Chlorosuccinimide solutions will oxidize bromide and iodide to the corresponding halogens. These can then be identified by extraction with CHCl₃ or CCl₄. HAZARDS: chloroform, carbon tet. - substitute CH₂Cl₂.

*ANAL QUAL 2 3

The Nine-Bottle Experiment Revisited

Finholt, J. E.

J. Chem. Educ. 61,849 (1984)

Suggested modifications in a celebrated old experiment, challenging students' knowledge and ingenuity.

*ANAL NOPROC QUAL 2

Versus/Versus - A Lab that Students Don't Dread

Flath, P. C.; Uhorchak, R. E.

J. Chem. Educ. 55,335 (1978)

Reports successful use of a "same or different" qual. experiment.

*ANAL CONSUMERPROD GC 3 HAZARD

Polyunsaturation in Margarines

Flynn, J. J.

J. Chem. Educ. 54,322 (1977)

BF₃/CH₃OH as methylating agent in transesterification. GC analysis requires standard fatty acid methyl ester sample.

HAZARD (avoidable): Benzene used in extraction; use a substitute.

*ANAL ORG CONSUMERPROD IR TLC 3

Partial Analysis of Vinyl-Asbestos Floor Tile: A TLC Experiment for Beginning Organic Chemistry

Foreman, W. A.; Paulson, D. R.

J. Chem. Educ. 49,572 (1972)

Tetrahydrofuran extraction gives polymer, analyzed by IR of thin film and plasticizer. TLC analysis with bis(2-ethylhexyl)sebacate as a standard. R_f values given for various plasticizers.

*ANAL. QUAL. QUANT. 3

Combining Preparative and Quantitative Procedures in Qualitative Analysis
Fowles, G. W. A.

J. Chem. Educ. 39,401 (1962)

Experiments designed to combine preparative, qualitative analysis, and illustration of properties as alternative to qual. scheme. Here qualitative exp'ts on vanadium, copper, gold, determination of valency states of vanadium, preparative for tris-(thiourea)copper(I) chloride, quant. for copper.

*ANAL. ORG. COLOR. COLUMN. 2 3

Dye Unknowns for Use in Column Chromatography

Freese, J. M.; Olesen, B.; Pinnick, H. R., Jr.; Ussted, J. T.

J. Chem. Educ. 54,684 (1977)

Pedagogic. 12 candidates for adsorption on an alumina column may be permuted into 36 different mixtures, so that each student has his/her own unknown. 95% ethanol followed by water.

*ANAL. ELECTRODE. IONSELECT. 3

Inexpensive Solid-State Ion-Selective Electrodes for Student Use

Fricke, G. H.; Kuntz, M. J.

J. Chem. Educ. 54,517 (1977)

Methods for construction of various ion-selective electrodes given, from silver chloride and from silver sulfide-metal sulfide coprecipitates and silicone grease, together with a list of suggested experiments. A student can prepare one of these electrodes and use it to test for Ag⁺ in one lab period, and for Cl⁻ or metal ratios in a second period.

*ANAL. PAPER. UVIS. 4

A Quantitative Experiment with Paper Chromatography

Frierson, W. J.; Marable, N.; Bruce, B.

J. Chem. Educ. 40,408 (1963)

Determination of Zn, Cu, Co, Ni. Samples recovered from chromatogram and analyzed colorimetrically (Spec-20). Reagents: dithione, rubenic acid, 1,2,3-cyclohexanetrione trioxime, Zinon reagent. Six 3-hr lab periods.

*ANAL. TECHNIQUE. TLC. UVIS. 3

Reflectance Spectroscopic Analysis of Dyes Separated by Thin Layer Chromatography

Prodyma, M. M.; Frei, R. W.

J. Chem. Educ. 46,522 (1969)

Beckman DU with std. reflectance attachment. This paper reports results of student experiment in intro. anal. chem. on identification of the components of a dye mixture, and quant. anal. for one component. Requires standard dye samples.

*ANAL. BIOCHEM. NOPROC. PROJ. TITN. VITAMIN. 2

Vitamin C and the Diet of a Student

Fulkrod, J. E.

J. Chem. Educ. 49,738 (1972)

Describes successful classroom use of 2,6-dichlorophenolindophenol titration to determine Vitamin C in urine. For non-majors.

*ANAL. GRAVIM. 1 2 HAZARD

The Determination of Copper in a Copper-Nickel Alloy: A New Experiment for the General Chemistry Laboratory

Gallagher, K.; Cantor, C. R.

J. Chem. Educ. 55,660 (1978)

Coinage alloy dissolved in nitric acid, then heated in conc. sulfuric. HAZARD: toxic vapors (nitrogen oxides, sulfur trioxide), but no mention. Copper pptd. as copper(I) thiocyanate, weighed. Designed for large classes.

*ANAL. BIOCHEM. UVIS. 2 3

Determination of p-Aminobenzoic Acid in Urine

Gammans, R. E.; Stewart, J. T.

J. Chem. Educ. 51,275 (1974)

Standard p-aminobenzoic acid is used. Unknowns constructed from urine and added p-aminobenzoic acid. Spec-20. Color development by diazotization and coupling with N-(1-naphthyl)ethylenediamine.2HCl.

*ANAL. INORG. QUAL. SOLUB. 2 HAZARD

Detection of Thiocyanate and Dissolution of Silver Halides

Gentil, V.; Caldas, A.; Oesper, R. E.

J. Chem. Educ. 36,386 (1959)

A very short note on the separation of thiocyanate from the other four ions of the chloride group of anions in the conventional qual. scheme. HAZARD: SCN⁻ is converted to CN⁻ and S=.

***ANAL ORG CHROMATOG FRIEDEL-CRAFTS ORGANOMETAL 4**

The Separation of Ferrocene, Acetylferrocene and Diacetylferrocene: A dry-column chromatography experiment

Gilbert, J. C.; Monti, S. A.

J. Chem. Educ. 50, 369 (1973)

Column - alumina, eluant - CH_2Cl_2 . Sample is prepared by Friedel-Crafts acylation of ferrocene with acetic anhydride/phosphoric acid (reference given). Technique of dry-column thoroughly explained.

***ANAL ENVIRON UVIS WATERCHEM 3 HAZARD**

Nitric Acid in Rain Water.

Gleason, G. I.

J. Chem. Educ. 50, 718 (1973)

Cadmium amalgam reductor converts nitrate to nitrite. This is subjected to azo dye formation and subsequent colorimetric analysis. Reductor requires glass-blowing. Reagents: 1-naphthyl-ethylenediamine, sulfanilic acid. HAZARD: cadmium powder - MUST WEAR RESPIRATOR.

***ANAL CONSUMERPROD UVIS 2**

Determination of Nitrite in Meat Samples

Glover, I. T.; Johnson, F. T.

J. Chem. Educ. 50, 426 (1973)

Hot water extraction of processed meat products in a blender. Color-developing reagent is N-(1-naphthyl)ethylenediamine.

***ANAL GC NOPROC PESTICIDE TLC UVIS 4**

Analysis of Chlorinated Hydrocarbon Pesticides: Experiments for Nonscience Majors

Glover, I. T.; Minter, A. P.

J. Chem. Educ. 51, 685 (1974)

TLC (silica gel) for DDT, Dieldrin, etc. Quant. UV spectrophotometry on eluate. Internal standard: Benzophenone. Further analysis, GC - flame ionization detector. Advanced level of experimentation.

Caution: pesticides - extr. toxic

***ANAL CHROMATOG PHASE 3**

An Experiment Illustrating Countercurrent Chromatography With Simple Apparatus

Godinho, O. E. S.; Braga, G. L.

J. Chem. Educ. 52, 258 (1975)

Sep'n of bromocresol purple and phenol red. In this technique, 1-butanol is the unsupported stationary phase. The moving phase is 0.05M Na_2CO_3 . Apparatus simply constructed.

***ANAL COORD ELECTROANAL GLOBEB KEQ 3**

Formation Constants of a Metal-Amine System: Potentiometric titration experiment

Goldberg, D. E.

J. Chem. Educ. 39, 328 (1962)

Formation constants for copper-ethylenediamine by titration in stirred apparatus under nitrogen. Caution: perchloric acid, although used in dilute soln, is a storage hazard. Much detail on theory.

***ANAL QUAL TLC 2**

Cation Analysis with Thin Layer Chromatography

Goller, E. J.

J. Chem. Educ. 42, 442 (1965)

Alumina thin layer plates; construction detailed. Ordinary lab glassware. Moving phase is (NaBr/1M HCl)/isopropanol. Visualization by DMG, etc., sprays. Ordinary qual cations and reagents.

***ANAL AA-FP 2**

Determination of Sodium in Salt Substitute by Flame Emission Spectroscopy

Goodney, D. E.

J. Chem. Educ. 59, 875 (1982)

Straightforward. Na^+ standard is made by weighing out and dissolving pure, dry NaCl in water. Student must prepare a calibration curve and calculate concentration of sodium in his/her sample.

***ANAL COMPLEX DEMO GRAVIM 4**

Precipitation from Homogeneous Solution: A lecture demonstration

Gordon, L.; Salesin, E. D.

J. Chem. Educ. 38, 16 (1961)

Precipitation of Ni^{++} with DMG generated homogeneously from biacetyl and hydroxylamine.

***ANAL COMPUTER ERROR NEUTRON NOPROC PROJ 3**

Analysis of Binary Ammonium Salts: Evaluation of error by computer program

Gordus, A. A.; Hanson, J. C.

J. Chem. Educ. 42, 485 (1965)

Students get a mixture, analyze it qual. and quant. NH_4^+ by Kjeldahl, anions by method of their choosing. Computer program to analyze errors. Neutron radiation analysis for halide.

***ANAL CALORIMETRY CONSUMERPROD INSTR TITN 3**

Determination of Ammonia in Household Cleaners

An Instrumental Analysis Experiment

Graham, R. C.; DePew, S.

J. Chem. Educ. 60,765 (1983)

Thermometric titration with HCl in state-of-the-art adiabatic titration calorimeter.

***ANAL CHROMATOG INSTR 4**

Determination of Sulfur in Fuel Oils: An Instrumental Analysis Experiment

Graham, R. C.; Robertson, J. K.; Loehle, W. D.

J. Chem. Educ. 59,340 (1982)

Parr oxygen bomb with electrical ignition. NaHCO₃ solution in bottom of bomb absorbs SO₃; this is quantitatively diluted and analyzed with an ion chromatograph. Well-designed experiment; complete safety analysis.

***ANAL CONSUMERPROD PH 1**

The pH of Hair Shampoos. A Topical High School Experiment.

Griffin, J. J.; Cocoran, R. F.; Akana, K. K.

J. Chem. Educ. 54,553 (1977)

The pH of the more popular brands of shampoos have been determined both directly from bottle and in 1/10 dilution. Relevance for hair cleaning discussed.

***ANAL APPARATUS ELECTROANAL REDOX 3**

Coulometry Using Simple Electronic Devices

Grimsrud, E.; Amend, J.

J. Chem. Educ. 56,131 (1979)

Two coulometry experiments: 1) Hydrazine by electrically generated bromine, 2) Ferrous in ferrous salts. Operational amplifier.

***ANAL ORG DRYLAB GC ISOMERS MASSPEC 3**

Illustrating Gas Chromatography and Mass Spectrometry: An undergraduate experiment

Gross, M. L.; Olsen, V. K.; Force, R. K.

J. Chem. Educ. 52,535 (1975)

GC separation of isomeric ketones. Mass spec. can be done as a dry lab.

Unknown (mixture of six C₆H₁₂O, or C₇H₁₄O, ketones).

***ANAL INORG QUAL 2**

Blue-Violet For Nitrate Ion

Grotz, L. C.

J. Chem. Educ. 50,63 (1973)

In highly acidic solution, nitrate oxidizes colorless diphenylamine to diphenylbenzidine violet (which is blue). Prepn. of reagent, interferences described.

***ANAL DIFFUSION GAS GC INSTR NOPROC 4**

Measurements of Gaseous Diffusion Coefficients by Gas Chromatography

Grushka, E.; Maynard, V.

J. Chem. Educ. 49,565 (1972)

Diffusion coefficient of gaseous mixture (He-Ne). Requires GC w. 20 feet of one-quarter inch metal tubing. Chromatographic theory introduced.

***ANAL PHYS DEMO DISTRIB NOPROC PHASE 4 HAZARD**

The Diisopropyl Ether Extraction of Iron(III) Chloride

Guenther, W. B.

J. Chem. Educ. 42,277 (1965)

Three liquid layer demonstration. Used also for iron(III) estimation from phase diagram. HAZARD: diisopropyl ether forms explosive peroxides if stored dry.

***ANAL ACBA QUAL TITN 3**

Wood Ash Analysis: An Experiment for Introductory Courses

Guenther, W. B.

J. Chem. Educ. 59,1047(1982)

Quant. for total base, soluble base; qual. for cations.

***ANAL CONSUMERPROD PROJ REDOX TITN VITAMIN 2**

Vitamin C Content of Commercial Orange Juices: An Analytical Project

Haddad, P.

J. Chem. Educ. 54,192 (1977)

Reagents: either 2,6-dichlorophenolindophenol or N-bromosuccinimide; each standardized with ascorbic acid.

***ANAL CONSUMERPROD HPLC INSTR PHARM 4**

High Performance Liquid Chromatography of Some Analgesic Compounds: An Instrumental Analysis Experiment
Haddad, P.; Hutchins, S.; Tuffy, M.
J. Chem. Educ. 60,166 (1983)
Designed to demonstrate solvent selection, gradient elution, pH control, and ion pairing via analysis of several analgesics using reversed phase LC on an octadecylsilane column. Waters Associates analysis system. Detailed.

***ANAL ASPIRIN DISTRIB IR PHARM QUANT UVIS 2 3 HAZARD**

Separation of an APC Mixture: A Quantitative Analysis Experiment
Haddad, P.; Rasmussen, M.
J. Chem. Educ. 53,731 (1976)
Multipurpose experiment to illustrate basic separation and identification techniques. Two 3.5-hour lab periods. HAZARD: CHCl_3 - carcinogen.

***ANAL INORG QUAL SOLUB 3 HAZARD**

Separation of Mn and Zn from Co and Ni by Fractional Dissolution of Their Sulfides
Hahn, R. B.; Sanders, C. H.; Gutnikov, G.
J. Chem. Educ. 37,412 (1960)
The combined sulfides of Mn^{++} , Zn^{++} , Co^{++} and Ni^{++} are treated (1) with 1M HOAc , which dissolves out the Mn^{++} , (2) 2M HCl , which dissolves out the zinc (+ small quant. of the other two ions). Separation and identification scheme given for the three resulting solutions. HAZARD: thioacetamide is a carcinogen.

***ANAL CHROMATOG DISTRIB ENVIRON GC PESTICIDE 4**

DDE Levels in Birds: An environmentally oriented undergraduate experiment
Hall, S.; Reichardt, P. B.
J. Chem. Educ. 51,684 (1974)
Intended for an environmental chemistry course. A technique experiment acetone/hexane extraction using Soxhlet extractor; column chromatography uses Celite column; flame ionization GC. Warning: toxic compounds.

***ANAL BIOCHEM NOPROC TECHNIQUE 4**

Sedimentation Coefficient, Frictional Coefficient, and Molecular Weight: A Preparative Ultracentrifuge Experiment for the Advanced Undergraduate
Halsall, H. B.; Wermeling, J. R.
J. Chem. Educ. 59,1076(1982)
Mostly theory. Sedimentation coefficients are related to molecular shape, but there is no experiment described.

***ANAL GC IR NOPROC SEQ UVIS 3**

Xylene Analysis: Integrated experiment in instrumental analysis
Hanrahan, E. S.
J. Chem. Educ. 43,321 (1966)
A sequential, rather than integrated lab. Students use the first two methods to analyze impure alkyl benzenes (GC), with literature references only. UVIS is a supplement.

***ANAL INSTR TECHNIQUE UVIS 4**

The Principles of Flow Injection Analysis as Demonstrated by Three Lab Exercises
Hansen, E. H.; Ruzika, J.
J. Chem. Educ. 56,677 (1979)
State-of-the-art automated procedures. 1) phosphate by formation of phosphomolybdenum blue, 2) chloride in sea water, 3) HCl by a "titration" procedure. Spectroscopic detection. Detailed presentation.

***ANAL PHYS ACBA APPARATUS HEAT TITN 4**

A Thermometric Titration Experiment for Analytical and Physical Chemistry
Hansen, L. D.; Kenney, D.; Litchman, W. M.; Lewis, E. A.
J. Chem. Educ. 48,851 (1971)
Titration, with a strong acid, of mixtures of tris-(hydroxymethyl)amino-methane and pyridine. Constant rate buret, recording Wheatstone bridge.

***ANAL INORG DISTRIB QUAL 2 HAZARD**

Chloride, Bromide, and Iodide Determination
Hanson, M. W.
J. Chem. Educ. 38,412 (1961)
By oxidation to the free elements I_2 and Br_2 with a) dilute and b) more concentrated HNO_3 . The elements are then extracted from the aq. layer with CCl_4 . NOTE from Stony Brook: we found that this oxidation does not work well enough for use in qual.anal. HAZARD: CCl_4 - replace with CH_2Cl_2 .

***ANAL INSTR UVIS 4**

Simultaneous Spectrophotometric Analysis of a Three-Component Mixture: An experiment for Instrumental Analysis
Harker, G. G.; Huntington, J. L., Jr.; Gruber, T. A.; Hargis, L. G.
J. Chem. Educ. 47,712 (1970)
Beckman DU; o-, m-, and p- cresols. Caution: all three cresols can attack skin and produce serious poisoning symptoms, such as loss of sensation. Wear gloves. Study questions given.

***ANAL STOICH TITN 3**

The Barium Hydroxide-Ammonium Thiocyanate Reaction. A Titrimetric Continuous Variations Experiment.

Harris, A. D.

J. Chem. Educ. 56,477 (1979)

Barium hydroxide and ammonium thiocyanate react spontaneously in the solid state to yield ammonium hydroxide which decomposes to ammonia and water. The ammonia is collected in boric acid and titrated with standard HCl, as in the classical Kjeldahl method. Simple apparatus for ensuring quantitative recovery of the ammonia described.

***ANAL. INORG DTA GRAVIM STOICH 2**

Decomposition of Copper(II) Sulfate Pentahydrate

Harris, A. D.; Kalbus, L. H.

J. Chem. Educ. 56,417 (1979)

Stepwise removal of bound water, ignition to cupric oxide. Requires 400 deg. Celsius furnace.

***ANAL APPARATUS ELECTROANAL 3**

A Chemical Polarograph

Harris, W. E.

J. Chem. Educ. 35,408 (1958)

Simple polarograph (construction details) used for thallium analysis.

CAUTION: thallium toxicity.

***ANAL CONSUMERPROD DEMO PAPER C 2**

Paper Disc Chromatography

Hart, H.

J. Chem. Educ. 36,450 (1959)

Chem-Ed Tested Demo. Rapid separation of food colorings.

***ANAL INSTR REFRACT 3**

Qualitative Analysis of Xylene Mixtures by Refractometry

Hartkopf, A.; Schroeder, R. R.; Meyers, C. H.

J. Chem. Educ. 51,405 (1974)

Refractometry used in conjunction with IR. Straightforward.

***ANAL QUAL 2**

A New Single-Solution Confirmatory Test for Nitrite Ion

Hawthorne, R. M., Jr.; Ruthenberg, M. J.

J. Chem. Educ. 55,29 (1978)

A few drops of 1% aq. mercaptoacetic acid added to 1/2-ml sample of 1% sodium nitrite causes immediate development of characteristic salmon-pink color. Non-toxic, but has a mild hydrogen sulfide-like odor.

***ANAL QUAL 2**

Separating Copper and Cadmium in Qualitative Analysis

Hayden, D. W.; Hunt, R. L.

J. Chem. Educ. 59,59 (1982)

Note on use of iodide-thiocyanate to eliminate use of cyanide in Group 2 qual. scheme.

***ANAL ORG APPARATUS GC 4**

The Construction of a Simple Pyrolysis Gas Chromatograph

Hedrick, J. L.

J. Chem. Educ. 59,612 (1982)

Article describes the construction of the apparatus; extensions to undergraduate experiments suggested.

***ANAL ORG PAPER C 3 HAZARD**

Quick Paper Chromatography of Amino Acids

Heimer, E. P.

J. Chem. Educ. 49,547 (1972)

Acetonitrile/ammonium acetate, ninhydrin. Develop in 40 min. Rf values for 11 amino acids given. Author gives level as grad/undergrad.

Hazard: ninhydrin is a suspected carcinogen.

***ANAL ORG NATPROD TLC 3**

TLC Monitoring of Triglyceride Saponification

Heller, R. A.

J. Chem. Educ. 53,778 (1976)

Saponification of edible fat or oil followed by removing samples periodically and analyzing by TLC. A single spot gives way to multiple spots indicating formation of the di-, and mono-glyceride, and the free acid.

The intermediate products disappear and the TLC plates eventually show only one spot (free acid). Silica plate, hexane/ ethyl ether/HOAc developer, visualization by dichlorofluorescein under UV. Rf values given.

***ANAL. COMPUTER FLUOR 5 HAZARD**

The Effects of Absorption and Self-Absorption Quenching on Fluorescent Intensities

Henderson, G.

J. Chem. Educ. 54, 57 (1977)

2,3-Butanedione in CCl₄ gives fluorescence excitation spectra, measured spectrophotofluorometer and computer analyzed for self-absorption.

Hazard—CCl₄ is a carcinogen; substitute another solvent.

***ANAL. COMPUTER INSTR. NMR 5 HAZARD**

An NMR-Spectrophotometer Interface Experiment: Demonstrating How Signal Averaging Influences Signal-to-Noise Ratios

Henner, M.; Levoir, P.; Ancian, B.

J. Chem. Educ. 56, 684 (1979)

A simple interface system is described. Interface block diagram, command unit, flow diagram given. 1% ethylbenzene in CCl₄ (HAZARD: carcinogen).

***ANAL. GRAVIM 2**

Gravimetric Determination of Calcium as CaC₂O₄·H₂O

Henrickson, C. H.; Robinson, P. R.

J. Chem. Educ. 56, 341 (1979)

Complete instructions. Suitable for large classes.

***ANAL. INORG. REDOX TITN 2**

Oxidation State Determinations for Some Reaction Products of Vanadium(V).

A Multicolored Titration

Hentz, F. C., Jr.; Long, G. G.

J. Chem. Educ. 55, 55 (1978)

Multiple oxidation states; Zn-Hg and Fe(+2) reductions. Permanganate titrations. Starting material: ammonium metavanadate.

***ANAL. INORG. CONSUMERPROD. TITN 2 3**

Lighter Flint Chemistry

Hentz, F. C., Jr.; Long, G. G.

J. Chem. Educ. 53, 651 (1976)

Iron, cerium, apparent equivalent weight determined (by hydrogen evaluation).

***ANAL. GRAVIM. HANDICAPPED TITN 2**

A General Chemistry Experiment for the Blind

Hiemenz, P. C.; Pfeiffer, E.

J. Chem. Educ. 49, 263 (1972)

The blind can use a triple-beam balance. An apparatus for conductometric titration was modified to produce an audible signal. The two techniques, taken together, allowed a blind student to determine the molecular weight of an unknown acid (trichloroacetic).

***ANAL. ACBA. ELECTROANAL. NONAQ. TITN 4 HAZARD**

A Nonaqueous Conductometric Titration for the Analysis of Alkaloids in Cigarette Tobacco

Hiller, J. M.; Mohan, M. S.; Brand, M. J.

J. Chem. Educ. 56, 207 (1979)

Conductometric titn. in glacial acetic acid medium. Caution: skin irritants, toxic extract. Hazards: HClO₄ is a storage hazard; CCl₄ is carcinogenic; substitute another solvent.

***ANAL. COORD. DISTRIB. UVIS 4 HAZARD**

Iron(III) Determination Using Liquid-Liquid Extraction and Colorimetry

Holt, R. L.; Easley, W. K.

J. Chem. Educ. 42, 276 (1963)

8-Hydroxyquinoline (oxime) extraction is followed by direct colorimetric detn. of complex. Hazard: chloroform (solvent) is a carcinogen.

***ANAL. QUAL. QUANT. UVIS 2**

Qualitative and Colorimetric Analysis of Salicylic Acid

Hoops, S. C.

J. Chem. Educ. 51, 782 (1974)

Simple color tests establish the basis for the quantitative determination of salicylic acid in urine by quantitative colorimetry. Designed for non-majors.

***ANAL. AA-FP. INSTR. 4**

An Atomic Absorption Interferences Experiment: An Advanced Exercise for the Undergraduate Analytical Laboratory

Hosking, J. W.; Snell, N. B.; Sturman, B. T.

J. Chem. Educ. 54, 128 (1977)

Effect of variables in calcium analysis. Detecting and overcoming interferences (Al, Mg, Cl⁻, PO₄³⁻, Sr, Na, La). Four 3-hr. lab periods.

*ANAL AA-FP DISTRIB INSTR 3

Determination of the Extraction Constant for Zinc Pyrrolidinecarbodithioate
An atomic absorption experiment for instrumental analysis
Hoskins, L. C.; Reichardt, P. B.; Stolzberg, R. J.
J. Chem. Educ. 58,580 (1981)
Intended for an instrumental analysis course. The extraction of zinc from aqueous solution as the title complex by methyl isobutyl ketone is studied by direct AA analysis of the phases.

*ANAL COORD PHOTO UVIS 3 HAZARD

A Simple Method for the Analysis of Cobalt in Co(III) Complexes
Hughes, R. G.; Endicott, J. F.; Hoffman, M. Z.; House, D. A.
J. Chem. Educ. 46,440 (1969)
Mercury lamp photolysis or boiling with K₂S₂O₇ gives Co(II), determined colorimetrically. WARNINGS: UV radiation, ozone evolution, HClO₄ (storage hazard), Co(III) complexes may decompose violently on heating.

*ANAL ORG TLC UVIS 3

TLC Separation and Spectrophotometric Analysis of o- and p-Nitroaniline
Hurlbut, J. A.
J. Chem. Educ. 48,411 (1971)
Preparative TLC; silica plates; moving phase is ethyl acetate. Abs. maxima and R_f values given. Two 3-hr. lab periods. Caution: both amines are toxic and absorb through skin.

*ANAL AA-FP NOPROC 3

Determination of Trace Quantities of Chromium and Manganese in Steel, Ore, and Liquid Samples by Atomic Absorption Spectrometry
Hurlbut, J. A.; Gilbert, L. K.; Buddington, B. N.; Rees, T. F.
J. Chem. Educ. 51,734 (1974)
Note describes successful use of AA in analysis of steel, etc., for chromium and manganese. Two 3-hr. lab periods.

*ANAL INORG QUAL 3 HAZARD

Identification of Copper and Cadmium: A method without the use of KCN
Husted, H. G.
J. Chem. Educ. 35,403 (1958)
Advantage is taken of the amphoteric nature of cupric hydroxide to separate it from Cd(OH)₂ which is not amphoteric. 8M NaOH. Copper is identified as the ferrocyanide, cadmium as the sulfide. HAZARD: avoid cadmium.

*ANAL APPARATUS MAGNETIC TECHNIQUE 4

Determination of Pyrite in Coal and Lignite by Thermomagnetic Analysis
Hyman, M.; Rowe, M. W.
J. Chem. Educ. 59,424 (1982)
A new method of analysis of ferromagnetic materials combines ordinary thermal analysis with the change in weight in a magnetic field. Schematic of the Faraday balance given. Suitable for routine operation in an undergraduate laboratory.

*ANAL QUAL 2

The Detection of Strontium and Calcium
Isenberg, N.; Collins, C.; Strax, P.; MacFarland, S. A.
J. Chem. Educ. 39,401 (1962)
Short note suggests removal of any chromate as Ag₂CrO₄, and excess Ag⁺ as AgCl before precipitating oxalates. This is to prevent darkening of triethanolamine used in the Sr/Ca separation.

*ANAL QUAL 2 HAZARD

Errors in the Detection of Cadmium: Light-colored copper-thioacetamide complexes
Isenberg, N.; Kreger, H. J.; Middleton, R. H.
J. Chem. Educ. 43,422 (1966)
Cautions that metal complexes with thiourea may give false positive cadmium test. HAZARD: thiourea is a suspected carcinogenic.

*ANAL INORG QUAL 3 HAZARD

Analysis of Mercury(II) Salts With Thioacetamide
Isenberg, N.; Perlman, E.; Puryear, R.; Sparks, S. A.
J. Chem. Educ. 35,404 (1958)
A note reporting that the orange HgS precipitated by thioacetamide does not differ from the ordinary black ppt with H₂S, as far as the qual. scheme is concerned. HAZARD: thioacetamide is a carcinogen.

*ANAL ORG CATAL GEOM UVIS 4

Quantitative Analysis by Ultraviolet Spectroscopy of the cis-trans Stilbene System
Ish-Shalom, M.; Fitzpatrick, J. D.; Orchin, M.
J. Chem. Educ. 34,496 (1957)
Selenium (0.1 percent) at 210 degrees C, analysis by UV (Beckman DU).

*ANAL BIOCHEM PAPERC 3

Quick Paper Chromatography of Monosaccharides

Ivany, J. W. G.; Heimer, E. P.

J. Chem. Educ. 50,562 (1973)

Devised for beginning biochem lab. R(glucose) values for 21 monosaccharides. Acetonitrile-aq.NH₄OAc soln. at pH 7 gives resolution in 1 hour.

*ANAL PHYS ELECTROANAL TITN 4

An Undergraduate Electroanalytical Experiment

Janata, J.

J. Chem. Educ. 53,399 (1976)

Determination of vanillin by amperometric titration with standard 2,4-dinitrophenylhydrazine; dropping mercury electrode.

*ANAL ELECTROANAL 3

Potentiometric Determination of Mixed Halides

Jaques, D.

J. Chem. Educ. 42,429 (1965)

AgNO₃/iodide, bromide, chloride. Unknown, potentiometric titration.

*ANAL COLUMNC DISTRIB GC PESTICIDE PROJ TLC 4 HAZARD

The Determination of Pesticide Residues

Jarosch, R.

J. Chem. Educ. 50,507 (1973)

Florisil column for preliminary purification. Separation: TLC (silica gel).

Visualization: Rhodamine-B (R_f values given), or GC (electron capture).

Fish, soil, etc. samples. HAZARDS: carcinogens: CCl₄,CHCl₃, and benzene;

Warning: pesticides are extremely toxic.

*ANAL CALORIMETRY TECHNIQUE 3 4

Study of the Periodate Oxidation of alpha-Diols by Direct Injection

Enthalpimetry

Jeffries, D.; Fresco, J.

J. Chem. Educ. 51,545 (1974)

New technique for quantitative analysis, millimolar and micromolar range. Measure temperature rise by thermistor, bridge.

*ANAL QUAL 3

Neothorin Spot Test for Zirconium and Hafnium

Johnson, A. R., Jr.

J. Chem. Educ. 42,439 (1965)

Neothorin is almost specific for Zr and Hf. Explicit procedures for spot tests.

*ANAL PHYS KIN SIMULATION THERMO 2 3

Simulation and Data Reduction Programs

Johnson, K. J.

J. Chem. Educ. 57,406 (1980)

Some computer simulated experiments, mostly analytical, are listed. One is briefly described. Fortran.

*ANAL DEMO EDTA REVIEW TITN 4

EDTA and Complex Formation

Johnston, M. B.; Barnard, A. J., Jr.; Flaschka, H. A.

J. Chem. Educ. 35,601 (1958)

Nine experiments involving EDTA titrations developed to illustrate the use of this reagent. Explicit directions both for the titrations and for the preparation of the necessary solutions. 18 references.

*ANAL EDTA PROJ 2 3

Investigation of Some Metallochromic Indicators

Jones, A. V.; Nelson, M.

J. Chem. Educ. 56,755 (1979)

Introductory EDTA experiments include total hardness and calcium alone, in tap water. Effect of variation of pH, metal ion, etc., also studied. Extensions.

*ANAL INORG QUAL 2

A New Qualitative Reagent for Aluminum

Jones, C. T.; Williams, M. B.

J. Chem. Educ. 38,411 (1961)

Arsenazo,3-(2-arsenophenylazo)-4,5-dihydroxy-2,7-naphthalenedisulfonic acid, gives a reddish-purple coloration with Al+++.

***ANAL COORD CRYSTAL GRAVIM 4**

Precipitation from Mixed Solvents: A Demonstration

Jones, J. L.

J. Chem. Educ. 45,433 (1968)

Ni(DMG)₂ shows various crystal habits depending on conditions of precipitation. Not a lecture demo.

***ANAL UVIS 2**

A Simple Practical Lab Test For Freshman Students

Jones, M. M.

J. Chem. Educ. 54,178 (1977)

Student prepares a K₂CrO₄ solution by accurate weighing and dilution. Instr. measures abs. 475 nm.

***ANAL ACBA DISTRIB TITN 2 3**

A Simple Liquid-Liquid Extraction Experiment for Freshmen

Jones, M. M.; Champion, G. R.

J. Chem. Educ. 55,119 (1978)

n-Amyl alcohol-water-salicylic acid. Explicit procedure. Anal. by tit'n. Toxicities of compounds used given; none are very toxic.

***ANAL INORG QUAL 2**

Spot Test for Detection of Manganese

Kadarmandalgi, S. G.

J. Chem. Educ. 41,437 (1964)

Resacetophenone reagent (prep not given) suggested in qualitative analysis for Mn(II).

***ANAL INORG QUAL 2**

Resacetophenone Oxime Chelation of Copper in the Presence of Cadmium

Kadarmandalgi, S. G.

J. Chem. Educ. 41,438 (1964)

Improved separation of copper from cadmium without use of cyanide. Use is made of a new reagent, a derivative of resorcinol (prep not given).

***ANAL CONSUMERPROD HPLC INSTR PHARM 4**

Analysis of Currently Available Analgesic Tablets by Modern Liquid Chromatography: An Undergraduate Laboratory Introduction to HPLC

Kagel, R. A.; Farwell, S. O.

J. Chem. Educ. 60,163 (1983)

Adapted from a Waters Associates published experiment using reversed phase LC, this modification uses salicylic acid as an internal standard and a Dupont Zorbax C-8 bonded phase column. Detailed and straightforward.

***ANAL GRAVIM IR QUANT 3**

Use of Infrared Spectrophotometry in the Analysis of Limestone

Kalbus, G. E.; Kalbus, L. H.

J. Chem. Educ. 43,314 (1966)

Conventional anal. techniques supplemented by ir (KBr pellet) to determine what is taking place in the various anal. steps.

***ANAL ACBA STOICH TITN 3**

A Multifaceted Experiment for Quantitative Analysis: Back Titration, Hydroxide Determination, and Selection of an Indicator

Kalbus, L. H.; Petrucci, R. H.; Kalbus, G. E.

J. Chem. Educ. 53,719 (1976)

Determination of the hydroxide concentration of basic copper chromate illustrates back titration, hydroxide determination, indicator selection and titration curves. Dissolve weighed basic copper chromate in an aliquot of standard acid and back-titrate with hydroxide.

***ANAL GC QUANT 3**

Qualitative and Quantitative Gas Chromatography for the Undergraduate

Karasek, F. W.; DeDecker, E. H.; Tiernay, J. M.

J. Chem. Educ. 51,816 (1974)

Piezoelectric crystal detector permits room temperature operation of detector. Experiments given for quantitative analysis of aliphatic (C-6 to C-10) and aromatic hydrocarbon mixtures by peak height and width.

***ANAL EDTA IONX 4**

Separating Nd from Pr: A Laboratory Experiment in Ion-Exchange Chromatography

Kauffman, G. B.; Blank, J. S.
J. Chem. Educ. 37, 156 (1960)

The band of lanthanides absorbed on a column of DOWEX-50W is eluted with a buffered EDTA solution through a second column of DOWEX-50W in the copper(II) form. Since the copper-EDTA complex is more stable than either Ln-EDTA complex, the second column acts as a barrier through which the Ln-EDTA complexes cannot pass without decomposition, thus enhancing the sep'n. Experimental set-up diagrammed. Complete directions.

***ANAL COLUMNC GELC 3**

A Simple Apparatus for Teaching the Principles of Chromatography
Kellomaki, A.

J. Chem. Educ. 49, 139 (1972)

In these experiments Sephadex G-10 functions largely by GDC to separate by tap water elution Blue Dextran and then various salts (by size of anion). Elution volumes of salts by conductivity cell.

***ANAL ORG GC INSTR PREP TECHNIQUE 4**

An Application of Trimethylsilyl Derivatives with Temperature Programmed Gas Chromatography to the Senior Analytical Laboratory

Kelter, P. B.; Carr, J. D.
J. Chem. Educ. 60, 437 (1983)

Designed to teach temperature programmed GC. Students are asked to prepare TMS derivatives of fatty acids and develop an appropriate temperature program for analysis. Detailed; adequate hazard warnings are included.

***ANAL ELECTROANAL 3 HAZARD**

Controlled Potential Electrolysis: An experiment for elementary quantitative analysis

Kennedy, J. H.; Adamo, F.
J. Chem. Educ. 47, 461 (1970)

Diagram of cell given. Requires an integrator. Experiments performed are anodic electrolysis of (1) I⁻, (2) As(III), (3) Fe⁺⁺, and cathodic electrolysis of (4) Pb⁺⁺ and (5) Cd⁺⁺. HAZARD (avoidable) - Cd⁺⁺

***ANAL IONX QUAL 2**

Preparation of Solutions for Qualitative Analysis with a Cation Exchanger
Key, P.; Sohl, E.; Tiews, R.; Bricker, C.

J. Chem. Educ. 40, 416 (1963)

Results of student research: (1) Ion exchange replaces carbonate pptn. in qual. proc. (2) Trap construction for ident. of sulfide and carbonate.

***ANAL BACTERIA BIOCHEM ENVIRON GRAVIM REDOX 2**

A Demonstration of Bacterial Reduction of Inorganic Sulfate

Kinard, W. F.

J. Chem. Educ. 56, 559 (1979)

Determination of sulfate in mud samples from Charleston Harbor by barium sulfate pptn. and gravimetric analysis. The amount of sulfate in these samples falls off with time due to bacterial reduction of the sulfate to sulfide.

***ANAL ENVIRON UVIS WATERCHEM 2**

Nitrate Analysis: A laboratory experiment for the nonscience major course

King, D. M.; Lampman, G. M.; Smith, J. H., III

J. Chem. Educ. 48, 647 (1971)

Brucine used to detect and estimate nitrate in fresh water. Spec-20. Caution: brucine and its derivatives are extremely toxic.

***ANAL ELECTROCHEM HPLC INSTR NATPROD 4**

High Performance Liquid Chromatograph Experiments for Undergraduate Laboratories

Kissinger, P. T.; Felice, L. J.; King, W. P.; Pachla, L. A.; Riggan, R. Shoup, R. E.

J. Chem. Educ. 54, 50 (1977)

Liquid chromatography/electrochemical (amperometric) detection constructed. Preliminary purification and determination of ascorbic acid, uric acid, acetaminophen, etc. Very detailed procedure.

***ANAL QUAL 2**

An Improved Qualitative Analysis Procedure for Aluminum Subgroup Cations

Kistner, C. R.; Robinson, P. J.

J. Chem. Educ. 60, 1071 (1983)

Simple procedure to eliminate chromium interference with aluminum.

***ANAL QUANT SAFETY TITN 2 3**

The Fe(II)-Cr(VI) Reaction without Using Mercury

Klett, L. D.; Black, A. H.; Parker, G. A.

J. Chem. Educ. 61, 1020 (1984)

Ti+3 replaces Hg+2 for reacting with excess Sn+2 in the classical titration of iron with dichromate, thus eliminating the problem of mercury disposal.

*ANAL ORG QUAL 3

The Detection of Carboxylic Acids by Formation of Ferric Hydroxamates :
An improved method
Knight, D. W.; Cleland, G. H.
J. Chem. Educ. 47,781 (1970)
Data collection; variation on a method for qual. test for carboxylic acids.
Reagents are thionyl chloride, hydroxylamine hydrochloride, pyridine and ferric chloride.

*ANAL APPARATUS ENVIRON 1 2

Student Flowmeters and an Air Pollution Experiment
Kohn, H. W.
J. Chem. Educ. 49,643 (1972)
Glass wool absorbs hydrocarbon pollutants; amount shown roughly by heating to char afterward. Two new student flowmeters are described, for approximate flow measurements.

*ANAL EDTA KSP NOPROC SOLUB 3

The Solubility of CaSO_4 : An Ion Exchange-Complexometric Titration Experiment for the Freshman Laboratory
Koubek, E.
J. Chem. Educ. 53,254 (1976)
Calcium ion conc. of sat'd calcium sulfate solutions determined by (a) ion exchange followed by titration of sulfuric acid produced and (b) EDTA titration. Experiment is designed to show effect of ion pair formation and solubilities. One 2-3 hr lab period. Procedures by reference.

*ANAL ORG COMPUTER GC TECHNIQUE 3

Mixed Stationary Liquid Phases for Gas-Liquid Chromatography
Koury, A. M.; Parcher, J. F.
J. Chem. Educ. 56,623 (1979)
Use of "window diagrams" to predict effectiveness of mixed bed columns (2 component liq. phase). Exercise in selection of liquid phase in GC. Experiment is the measurement of retention time of several components on two single liquid phase (polar and non polar) columns. Construct window diagrams (can be computer aided), then preparation of mixed bed column, and separation of a mixture. Requires pure liquid phase, and components.

*ANAL GRAVIM NONAQ TITN UVIS 3

A Nonaqueous Gravimetric Titration. Determination of 8-hydroxyquinoline with p-Toluenesulfonic Acid in Acetonitrile
Kratochvil, B.; Findlay, E. J.; Harris, W. E.
J. Chem. Educ. 50,629 (1973)
Spec-20, syringe, detailed procedure given.

*ANAL ERROR STATISTICS TECHNIQUE 3

Sampling Error in a Particulate Mixture: An analytical chemistry experiment
Kratochvil, B.; Reid, R. S.; Harris, W. E.
J. Chem. Educ. 57,518 (1980)
Procedure and simple apparatus described to mix samples of potassium hydrogen phthalate and sucrose (30-40 mesh). KHP content determined by multiple titration using automatic zeroing burette. Standard deviation due to sampling error calculated from standard deviations of titration technique and of final KHP content.

*ANAL CONSUMERPROD ENVIRON QUAL 1

Analysis of Phosphates in Detergents
Kriz, G. S.; Kriz, K. D.
J. Chem. Educ. 48,551 (1971)
Pp_{tn} as ammonium phosphomolybdate. Designed for non-science students. Discussion.

*ANAL CONSUMERPROD EDTA TITN 2

Determination of Percent Na_4EDTA in Bathroom Cleaners
Kump, K. I.; Palocsay, F. A.; Gallaher, T. N.
J. Chem. Educ. 55,265 (1978)
Titn. with std. Mg^{+2} soln./Eriochrome Black-T.

*ANAL COORD EDTA PH TITN UVIS 3

Turbimetric Determination of Chelated Calcium at Various pH Levels: An Analytical Laboratory Experiment
L'Annunziata, M. F.; Fuller, W.
J. Chem. Educ. 46,172 (1969)
Excess Ca^{++} from titn. of EDTA ppts. as oxalate yielding turbidity. Abs. at 330 nm. measures turbidity.

*ANAL INORG QUAL 2

A Simple Method for the Detection of Soluble Bicarbonates
Lahiri, A. G.
J. Chem. Educ. 35,298 (1958)
Rapid test for soluble bicarbonate using a suspension of HgO in sat'd NaCl solution.

***ANAL. QUAL 3**

Some Analytical Reagents for Tin(II)-Tin(IV) Mixtures

Lal, S.; Srivastava, S. N.

J. Chem. Educ. 44,481 (1967)

Spot tests. Uses inorganic reagents, dyes.

***ANAL. QUAL 3**

Detection of Mercury(I) and Mercury(II) in the Presence of Each Other

Lal, S.; Srivastava, S. N.

J. Chem. Educ. 44,482 (1967)

Spot tests. Uses four different reagents; some are now known to be carcinogens.

***ANAL. QUAL 3**

Reagents for Analysis of Iron(II)-Iron(III) Mixtures

Lal, S.; Srivastava, S. N.

J. Chem. Educ. 44,482 (1967)

Spot tests. Uses three different reagents. Caution: Alpha-nitroso-beta-naphthol is a carcinogen and NH_4F is extremely toxic.

***ANAL. ENVIRON. QUAL. 2 HAZARD**

A Simple Qualitative Analysis Scheme for Several Environmentally Important Elements

Lambert, J. L.; Meloan, C. E.

J. Chem. Educ. 54,249 (1977)

Short scheme for separation and identification of 12 ecologically important cations provides "hands on" experience with qual anal. Hazard: cadmium, should be omitted. No sulfides or cyanides. Detailed.

***ANAL. CONSUMERPROD. ENVIRON. IONSELECT. WATERCHEM. 4**

Laboratory Experiments with Ion Selective Electrodes

Lamb, R. E.; Natusch, D. F. S.; O'Reilly, J. E.; Watkins, N.

J. Chem. Educ. 50,432 (1973)

Commercial ion selective electrode, pH meter or electrometer to 0.1 mV. Natural waters, vegetation, toothpaste. Caution: fluorides are extremely toxic.

***ANAL. ASPIRIN. FORENSIC. PHARM. QUAL. 1**

Qualitative Identification of Narcotics by Spot Test Examination

Lampe, K. F.

J. Chem. Educ. 35,96 (1958)

A series of spot tests developed by the School of Medicine at the University of Miami for use by untrained (ie., in chemistry) police officers for the identification of the common narcotics. Directions for the preparation of 4 color-producing reagents (ordinary chemicals) and a chart of the color reactions.

***ANAL. COMPLEX. INSTR. STOICH. UVIS. 2 HAZARD**

The Use of Nephelometric Measurements to Determine the Presence of Chelates

Land, J. E.

J. Chem. Educ. 34,38 (1957)

Job's method of continuous variation used to determine the formula of the copper(II)-cupferron ppt. Fisher nephelo-photometer with 525 nm filter. Within capacity of most univ. freshmen, but intended for an instrumental analysis course. Hazard: CHCl_3

***ANAL. TECHNIQUE. TITN. 3**

Titrimetric Determination of Sodium Salicylate in Blood: A Student Laboratory Experiment

Lane, S. R.; Stewart, J. T.

J. Chem. Educ. 51,588 (1974)

Diphasic titrimetry (organic solvent present) illustrates technique by titn of sodium salicylate in either whole blood or serum with a std. base. Caution: blood is an infection hazard.

***ANAL. INORG. PAPERCH. QUAL. 2**

Paper Chromatographic Identification of Gold, Platinum, Selenium, and Tellurium

Larsen, E.

J. Chem. Educ. 41,435 (1964)

Butanol, methanol, ether developer, spray detection.

***ANAL. AA-FP. CONSUMERPROD. 2**

The Iron Content of Breakfast Cereals

Laswick, P. H.

J. Chem. Educ. 50,132 (1973)

Atomic absorption spectrometer, dil. HCl extraction. Cereals, breakfast food. For non-science majors.

***ANAL ORG GRAVIM NONAQ TITN 3**

Piperazine as the Diacetate - An Organic Gravimetric Experiment

Latimer, G. W.

J. Chem. Educ. 43,148 (1966)

Unknowns; precipitate filtered in tared crucibles, dried in vacuum desiccator. Of limited application. Caution: piperazine is an irritant.

***ANAL ACBA NONAQ 3 HAZARD**

The Non-Aqueous Titration of the Salts of Weak Acids

Latimer, G. W., Jr.

J. Chem. Educ. 43,215 (1966)

Perchloric acid (explosion and storage HAZARD), 1M in acetic acid-acetic anhydride. Crystal violet indicator.

***ANAL COLUMNC DEMO 2 HAZARD**

Chromatography: Inorganic Separations Using Chalkboard Chalk

Lauren, P. M.

J. Chem. Educ. 44, A34 (1967)

Mixed cation solutions in test tube or beaker with chalk to permit upward migration. Develop colors by NH_3 , H_2S . HAZARD: H_2S is toxic, Cd a carcinogen.

***ANAL GC 2 3**

A Quantitative Gas Chromatographic Ethanol Determination

A Contemporary Analytical Experiment

Leary, J. J.

J. Chem. Educ. 60,675 (1983)

Simple construction of a calibration curve, using peak areas, and measurement of unknown samples. Thermal conductivity, constant temp. Student variation of flow rate and temp. requires some initiative.

***ANAL INORG GRAVIM STOICH 2**

A Simultaneous Analysis Problem for Advanced General Chemistry Laboratories

Leary, J. J.; Gallaher, T. N.

J. Chem. Educ. 60,673 (1983)

Mg ribbon ignited in air produces MgO and Mg_3N_2 . The weights of Mg , of the $\text{MgO} + \text{Mg}_3\text{N}_2$, and of the total MgO after the Mg_3N_2 is converted to MgO with water permit calculation of the relative amounts of MgO and Mg_3N_2 formed.

Reported used with a chem major group.

***ANAL PHYS AA-FP KSP 2**

Solubility of Lead Sulfate in Water and in Sodium Sulfate Solutions:

An Experiment in Atomic Absorption Spectrophotometry

Lehman, T. A.; Everett, W. W.

J. Chem. Educ. 59,797 (1982)

Designed to demonstrate variation in K_{sp} with ionic strength. Students must prepare a calibration curve, measure concentration of Pb^{++} in saturated solution above PbSO_4 crystals.

***ANAL INORG QUAL 2**

A New Short Method of Separating Lead From Bismuth Copper, and Cadmium

Lehrman, L.

J. Chem. Educ. 35,406 (1958)

PbSO_4 precipitates quantitatively on the addition of $(\text{NH}_4)_2\text{SO}_4$ to the nitric acid solution. Bi(III) , Cu(II) and Cd(II) do not interfere.

***ANAL INORG QUAL 3**

Semimicro Analysis of Alloys Containing Zirconium

Lehrman, L.; Dorenbusch, M.; Meisler, N.

J. Chem. Educ. 37,407 (1960)

Zirconium appears in Group III with iron and titanium in the classical qualitative analysis scheme. In the procedure given, the hydroxide ppt, which may contain Fe, Ti, or Zr is dissolved in HCl , zirconium is pptd as the arsenate from this sol'n, and det'd as its complex with Alizarin Red S. A rough estimate of the quantity of Zr can be obtained by counting the drops of 0.1M F- it takes to decolorize the sol'n.

***ANAL PHYS BIOCHEM DEMO PH 2**

An Effective Demonstration of the Behavior of Indicators and Biochemicals in Buffers

Lerman, C. L.; Doyle, R. R.

J. Chem. Educ. 53,634 (1976)

Obs. of color of p-nitrophenol, methyl red and bromocresol green at pH 0, 4, and 10 (in HCl , and carbonate and acetate buffers).

***ANAL BIOCHEM COLUMNC 3**

A Simple Laboratory Experiment on PVP Column Chromatography

Lerner, J.

J. Chem. Educ. 47,32 (1970)

Microseparation of vitamin B-12, riboflavin, and horse cytochrome c

on a polyvinylpyrrolidone column. Total effluent is 5 ml.

*ANAL. PHYS. ACBA ELECTROANAL IONSELECT KEQ TITN 3

Potentiometric Determination of Kw With the Glass Electrode

Liberti, A.; Light, T. S.

J. Chem. Educ. 39,236 (1962)

HCl-NaOH titration. Ag/AgCl ref. Cell protected from CO₂. Activity coefficients, liquid junction potentials.

*ANAL INSTR UVIS 4

A Simple Experiment Demonstrating the Relationship between Response Curves and Absorption Spectra

Li, C-y.

J. Chem. Educ. 61,827 (1984)

As the experiment is described, students assemble a single-beam spectrophotometer from modules. Directions using a Spec-20 are also given, but the use of modules gives students an understanding of variables. Students record ref. beam and sample beam measurements separately, and obtain absorption spectra from ratios (the tedious, old-fashioned way).

*ANAL ASPIRIN PHARM TLC 2 HAZARD

Analysis of APC Tablets: An inexpensive and practical thin-layer chromatography experiment

Lieu, V. T.

J. Chem. Educ. 48,478 (1971)

Uses a large chromatog. chamber or cut a bottle, UV lamp, std. sol'ns of caffeine, phenacetin, and acetylsalicylic acid, APC tablets. HAZARD: benzene, carcinogen, substitute.

*ANAL AA-FP APPARATUS ENVIRON 3

A Non-Flame Atomic Absorption Attachment for Trace Mercury Determination.

Lieu, V. T.; Cannon, A.; Huddleston, W. E.

J. Chem. Educ. 51,752 (1974)

Simple construction details given for air-sweep of sample by SnCl₂ solution into quartz-window long cell.

*ANAL ELECTROCHEM TITN 3

Analysis of Hypochlorite in Commercial Liquid Bleaches by Coulometric Titration

Lieu, V. T.; Kalbus, G. E.

J. Chem. Educ. 52,335 (1975)

Iodide-thiosulfate reaction. Also can be done potentiometrically.

*ANAL CONSUMERPROD ELECTROANAL IONSELECT REVIEW WATERCHEM 3

Determination of Fluoride in Toothpaste Using an Ion-Selective Electrode

Light, T. S.; Cappuccino, C. C.

J. Chem. Educ. 52,247 (1975)

LaF₃ membrane electrode, total ionic strength adjustment buffer, potentiometer, toothpaste, city water supply. Easy measurement. Discussion of other methods, activity coefficients. Questions for discussion. Caution: fluorides are toxic.

*ANAL INORG QUAL TLC 2

A Thin-Layer Chromatography Experiment For General Chemistry

Lincoln, S.; Pohl, R. A.; Haworth, D. T.

J. Chem. Educ. 47,401 (1970)

Separation of inorganic cations using microcrystalline cellulose, rods, plates. Classical qual. cations. 11 spray detection reagents, solvent systems, and R_f values outlined. Unknowns.

*ANAL DISTRIB TECHNIQUE UVIS 5

Counter-Current Distribution as a Student Laboratory Experiment

Lindblad, B.; Lindstedt, G.; Tiselius, H. G.

J. Chem. Educ. 46,525 (1969)

Two dyes distributed between two solvents in 5 separatory funnels.

*ANAL ELECTRODE INSTR IONSELECT 4

Student Preparation and Analysis of Chloride and Calcium Ion Selective Electrodes

Lloyd, B. W.; O'Brien, F. L.; Wilson, W. D.

J. Chem. Educ. 53,328 (1976)

Preparation of chloride ion and calcium ion liquid ion-exchange resins in PVC matrix. Emphasis on evaluating performance characteristics of the electrode.

*ANAL ORG ASSOC BIOCHEM DISTRIB HPLC INSTR 3 4 HAZARD

A Study of the Liquid-Liquid Partitioning Process Using Reverse-Phase

Liquid Chromatography: An undergraduate analytical chemistry experiment

Lochmuller, C. H.; Wilder, D. R.; Gutknecht, W. F.

J. Chem. Educ. 57,381 (1980)

Partition coefficients between mobile aqueous methanol and stationary hydrocarbon phases measured for benzene (toxic) and several substituted benzenes. Results related to Hansch hydrophobic substituent constants in octanol-water system, and Hansch model for drug distribution in organisms. Effect of molecular structure on partitioning discussed.

*ANAL GC 2

The Determination of the Alcohol Content of Beer—A General and Analytical Experiment with High Student Interest Value
Lokken, D. A.
J. Chem. Educ. 52,329 (1975)
Quantitative GC by peak height ratios with added propanol as internal standard
One 3-hr. lab period.

*ANAL CONSUMERPROD TITN 2

Mercurimetric Determination of Chloride in "Lite" Salt.
A Freshman Chemistry Experiment
Long, G. G.; Hentz, F. C., Jr.
J. Chem. Educ. 52,714 (1975)
Mixed KCl and NaCl analyzed. Indicator: diphenylcarbazone. RPI suggestion: diphenylthiocarbazone may be substituted for diphenylcarbazone.
"Lite" is a registered trademark.

*ANAL BIOCHEM DISTRIB GC NATPROD 4 HAZARD

Analysis of Lipid Content of Ground Beef: An Undergraduate Biochemistry Experiment
Long, G. L.
J. Chem. Educ. 52,813 (1975)
Samples injected as methyl esters. Methylating agent not specified.
Hazard: chloroform is a carcinogen; use a substitute.

*ANAL APPARATUS TITN UVIS 2 3

Colorimetric Titration Experiment for the Undergraduate Laboratory
Lopez, E.; Vassos, B. H.
J. Chem. Educ. 61,1025(1984)
Optical fibers permit measurements of very small sample volumes in colorimetric titrations. Apparatus is rugged, inexpensive, and easy to use. Written for the instructor.

*ANAL ORG TECHNIQUE 3 HAZARD

Oxygen Flask Semimicro Methods for Organic Sulfur and Phosphorus
MacDonald, A. M. G.; Stephen, W. I.
J. Chem. Educ. 39,528 (1962)
Modifications of titrations following oxygen flask combustion. Uses barium perchlorate for sulfate, and molybdate for phosphorus. HAZARD: 50% HClO₄ used in rgt prep, is a strong oxidant and explosive hazard.

*ANAL COMPUTER ELECTROANAL STATISTICS 4

Computer Evaluation of Titrations by Gran's Method: An analytical chemistry experiment
MacDonald, T. J.; Barker, B. J.; Caruso, J. A.
J. Chem. Educ. 49,200 (1972)
Computer-evaluation of data from potentiometric titration of Fe+2 with Ce(IV). This is not an interfacing experiment.

*ANAL GRAVIM STATISTICS 2

A "Relevant" First Experiment for Freshman Chemistry Laboratory
Macomber, R. S.
J. Chem. Educ. 49,714 (1972)
Popcorn weighed on an analytical balance before and after popping. This is a "first experiment" designed to teach analytical balance. Some statistical analysis.

*ANAL INORG UVIS 3

Simultaneous Spectrophotometric Determination of Cobalt and Chromium: A Student Experiment
MacQueen, J. T.; Knight, S. B.; Reilley, C. N.
J. Chem. Educ. 37,139 (1960)
Vis. spectrophotometer. Aq. nitrate solutions. Very time-consuming if recording spectrometer is not available.

*ANAL ASPIRIN PHARM TLC 3 HAZARD

Thin Layer Chromatogram Visualization
Madsen, B. C.
J. Chem. Educ. 50,852 (1973)
Silica gel containing a 254 nm phosphor. Rf values given for 12 common analgesics. Hazard: benzene is a carcinogen; use a substitute.

*ANAL ORG DEMO REVIEW TLC 2 3

TLC - Versatile Tool
Malins, D. C.; Wekell, J. C.
J. Chem. Educ. 40,531 (1963)
Experiments at several levels, involving separations of triglycerides. Studies of alcoholysis of triglycerides. An early "technique" set of experiments.

*ANAL PAPERC QUAL 2

A Rapid Paper Chromatographic Analysis of Group I Cations

Marion, S. P.; Psihas, J.

J. Chem. Educ. 34, 87 (1957)

A short note to describe use of paper chromatography to separate the ions of the Group I cations, so that advantage may be taken of the different colors of their chromates for identification.

*ANAL INORG QUAL 3

A Spot Test Analysis of the Group III Cations

Marion, S. P.; Zlochower, I.

J. Chem. Educ. 36, 379 (1959)

From the "Notes on Qual" column. Ni by DMG, Fe(III) by SCN⁻, Co by alpha-nitroso-beta-naphthol, Al by alizarin, Mn by bismuthate, Cr(III) by diphenylcarbazide and Zn by dithizone. Warning: many of these reagents are now known to be carcinogens.

*ANAL ORG ELECTROANAL KIN 4

Determination of Carbonyl Mixtures by a Differential Reaction Rate Method

Mark, H. B., Jr.; Greinke, R. A.

J. Chem. Educ. 46, 869 (1969)

Change in conductance with time in reaction of carbonyl compound and hydroxylamine hydrochloride, for standard and unknown plus standard in two different solvent systems gives composition.

*ANAL COMPUTER DRYLAB 4

A Data Acquisition Experiment for Instrumental Analysis

Markman, R. R.; Bean, P. L.; Heinrich, G. L.; Freeland, S. J.; Jakob, F.

J. Chem. Educ. 50, 295 (1973)

An output simulating a first order rate study with widely varying rate constant was used, students wrote program for acquiring and processing (A to D) data.

*ANAL ORG CONSUMERPROD NMR 3

An Analysis of a Commercial Furniture Refinisher

A Comprehensive Introductory NMR Experiment

Markow, P. G.; Cramer, J. A.

J. Chem. Educ. 60, 1078 (1980)

An introductory NMR experiment identifies components of Formby's Refinisher(TM). Semi-quantitative analysis by peak integration. Detailed; additional student directions are available.

*ANAL COLUMNC 3 HAZARD

Column Chromatography Experiment Using Unknowns

Marmor, S.

J. Chem. Educ. 42, 272 (1965)

Typical column chromatog. (but substitute for benzene eluant - HAZARD: carcinogen), except that colorless unknowns are used.

*ANAL ENVIRON NOPROC PROJ 3 4

Analysis of "Industrial Waste": A quantitative laboratory project

Marshall, D. R.; Owen, N. L.; Underhill, A. E.

J. Chem. Educ. 54, 584 (1977)

A synthetic "industrial waste" (water containing solvents, organics, and inorganic contaminants) is given to a student team for analysis by any method of their choice. 40 hours, and students must cooperate to finish. Qualitative and quantitative methods.

*ANAL ELECTROANAL TITN VITAMIN 2

Analysis of Commercial Vitamin C Tablets by Iodometric and Coulometric Titrimetry

Marsh, D. G.; Jacobs, D. L.; Veening, H.

J. Chem. Educ. 50, 626 (1973)

Procedures by reference. Detector circuit for endpoint given.

*ANAL APPARATUS ELECTROANAL INSTR IONSELECT 3 4

Coated-Wire Ion Selective Electrodes and Their Application to the Teaching Laboratory

Martin, C. R.; Freiser, H.

J. Chem. Educ. 57, 512 (1980)

Detailed directions for preparation, calibration and use of very simple and cheap nitrate and perchlorate sensitive electrodes. Procedures given for measuring solubility product of KClO₄ and NO_x content of air.

*ANAL STOICH 2 HAZARD

An Experiment for Introductory College Chemistry: How to Establish a Chemistry Equation

Masaguer, J. R.; Cota, M. V.; Cizas, J. S.

J. Chem. Educ. 52, 387 (1975)

Method of continuous variation. BaCl₂ + K₂CrO₄. Output parameter is height of ppt. in test tube. Hazard: Cr(VI) compounds are carcinogens.

***ANAL ORG PHYS KIN TITN 3 HAZARD**

The Oxidation of Secondary Alcohols with Cr(VI): A Kinetics Investigation of Steric Strain

Mason, T. J.

J. Chem. Educ. 59,980 (1982)

Rate of acid dichromate oxidation of sec. alcohols, e.g., cyclopentanol, in acetic acid/perchloric acid solution(CAUTION) is a measure of steric strain. Reaction is quenched with a sodium bicarbonate - potassium iodide mixture and the resulting iodine titrated with std thiosulfate to a starch endpoint.

HAZARDS: (I) unidentified highly exothermic reaction with inadequate provision for mishaps. (II) 70% perchloric acid is a storage hazard.

***ANAL INORG GAS 2**

Analysis of an Aluminum-Zinc Alloy

Masterton, W. L.

J. Chem. Educ. 38,558 (1961)

The old "equivalent weight of a metal" by measuring hydrogen evolved modified here by preparing alloys, analyzing composition.

***ANAL ACBA PROJ TITN 1 2**

The Preparation of Acid-Base Titration Curves

McClendon, M.

J. Chem. Educ. 61,1022(1984)

Complete directions are given for a simple titration apparatus, using a pH meter and a chart recorder to plot titration curves. High school students enjoy using it; some applications are mentioned.

***ANAL ENVIRON TITN WATERCHEM 2**

The Determination of Dissolved Oxygen by the Winkler Method: A Student Laboratory Experiment

McCormick, P. G.

J. Chem. Educ. 49,839 (1972)

Iodimetry. O₂ absorber: basic Mn(II). 60-ml plastic syringe. Natural waters.

***ANAL EDTA NATPROD TITN 2**

Titration of Calcium and Magnesium in Milk with EDTA

McCormick, P. G.

J. Chem. Educ. 50,136 (1973)

Mg indicator: calmagite. Ca indicator: hydroxy naphthol blue. Somewhat more challenging than water analysis.

***ANAL QUAL 2**

Qualitative Tests for K⁺

McCoy, R. E.

J. Chem. Educ. 42,444 (1965)

Corrects lab directions for confirming test for potassium ion after precipitation as potassium cobaltinitrite. Cobalt interferes.

***ANAL NATPROD PAPER C 2**

Sour Grapes - Why Are They?

McCullough, T.

J. Chem. Educ. 55,264 (1978)

Analysis of green and ripe grapes by paper chromatography. Solvent is ethyl acetate/ formic acid/ water; visualization by spraying with dichlorofluorescein in 1-propanol.

***ANAL ORG ACBA GRAVIM PAPER C TITN 3**

A Combined Gravimetric-Volumetric Analysis for Organic Chemistry

McCullough, T.

J. Chem. Educ. 51,279 (1974)

Unknown mixture of 2 simple organic acids. One is formic, determined by oxidation with mercury(II) chloride (gravimetric: mercury(I) chloride).

Neutral equivalent of mixture by acid-base. Paper chromatog.

***ANAL ORG PAPER C QUAL 3**

Detection of Chloride, Bromide, and Iodide Following Sodium Fusion

McCullough, T.; Allaire, P. N.; Boettcher, B. R.

J. Chem. Educ. 47,217 (1970)

Solvent: acetone-water. Visualization by dichlorofluorescein, AgNO₃.

***ANAL QUAL VISC 1 2**

Analysis of Alcohols

McCullough, T., Brother

J. Chem. Educ. 61,68 (1984)

Simple bending of tubing produces capillary viscometers. Unknown alcohols are identified by boiling point and viscosity. Capillary tubing of the size which seems to be required can be purchased, rather than drawn from tubing.

*ANAL BIOCHEM PAPERC 2

A Short, Intensive Experiment in Paper Chromatography

McCullough, T.; Lechtenberg, A.

J. Chem. Educ. 47, 141 (1970)

Amino acids. Improved developer (fast): EtOAc-formic acid-water. Some Rf values given.

*ANAL ORG CONSUMERPROD TLC 2 HAZARD

Detection of Butylated Hydroxyanisole (BHA) in Cooking Oils

McKone, H. T.

J. Chem. Educ. 53, 800 (1976)

Intended for non-science majors. BHA is separated from a cooking oil in hexane sample by extraction with ethanol and extract analyzed by TLC.

Silica plate, chloroform developer, visualization with ethanolic phosphomolybdic acid + ammonia gas. HAZARD: chloroform is carcinogenic; substitute ethyl acetate (?), dichloromethane (?).

*ANAL ORG CHROMATOG NATPROD TLC 3

The Rapid Isolation of Carotenoids from Food

McKone, H. T.

J. Chem. Educ. 56, 676 (1979)

An easier, shorter, less hazardous and more effective method for isolating pigments from tomato paste, strained carrots, and citrus skins, for TLC analysis in undergraduate instruction, is described.

*ANAL ORG CONSUMERPROD HPLC 3

High Performance Liquid Chromatography of Essential Oils

McKone, H. T.

J. Chem. Educ. 56, 698 (1979)

LC used to upgrade popular experiment on steam distillation of essential oils from grocery-store spices.

*ANAL COLOR CONSUMERPROD TLC UVIS 2

Identification of FD&C Dyes by Visible Spectroscopy: A Consumer-Oriented Undergraduate Experiment

McKone, H. T.

J. Chem. Educ. 54, 376 (1977)

Recording spectrophotometer. Extraction procedure by ref. Mixed food colors separated by silica gel TLC and elution. Absorption maxima for 11 food colors given.

*ANAL HPLC INSTR 4

An Introduction to High Performance Liquid Chromatography: Separation of Some FD&C Dyes

McKone, H. T.; Ivie, K.

J. Chem. Educ. 57, 321 (1980)

Analysis of food for 5 common dyes to teach HPLC. Previous separation and enrichment by SEP-PAK recommended.

*ANAL ORG COLOR CONSUMERPROD TLC 2

Separation and Identification of some FD&C Dyes by TLC. An Undergraduate Laboratory Experiment.

McKone, H. T.; Nelson, G. J.

J. Chem. Educ. 53, 722 (1976)

Jello dyes. Silica plates. 1-Butanol/ethanol/ammonia/water developer.

*ANAL INSTR UVIS 3

An Analytical Chemistry Experiment in Simultaneous Spectrophotometric Determination of Fe(III) and Cu(II) with Hexacyanoruthenate(II) Reagent

Mehra, M. C.; Rioux, J.

J. Chem. Educ. 59, 688 (1982)

Straightforward. The two cations form complexes that absorb at different visible wavelengths. Precision spectrophotometer. Procedure very brief; let student supply details.

*ANAL APPARATUS BIOCHEM NATPROD 3

Protein Nitrogen in Fruits, Vegetables, and Meats by a Modified Kjeldahl

Method: A quantitative analysis experiment

Meloan, C. E.

J. Chem. Educ. 39, 365 (1962)

Glass blowing required. Water content by azeotropic distillation. Normal Kjeldahl except steam distillation and modified apparatus.

*ANAL SOLUB 3

Pyrosulfate Fusion of Iron Ore: A quantitative analysis experiment

Meloan, C. E.

J. Chem. Educ. 39, 553 (1962)

Preliminary treatment of iron ore before analysis. No special apparatus.

*ANAL TECHNIQUE 1 2

Filtering Technique: A quantitative evaluation
Meloan, C. E.

J. Chem. Educ. 58,73 (1981)

Author describes tests to compare filtration time using "good" and "poor" gravity filtration techniques. Gives several useful technique tips. Not intended as student experiment.

*ANAL APPARATUS BIOCHEM ELECTROCHEM IONSELECT TECHNIQUE 4

An Ion-Selective Electrode/Flow-Injection Analysis Experiment

Determination of Potassium in Serum

Meyerhoff, M. E.; Kovach, P. M.

J. Chem. Educ. 60,766 (1983)

Students prepare a potassium ion selective tubular flow-through electrode and use it in an FIA system (schematic diagram). Detailed discussion; implicit procedure.

*ANAL COLOR QUAL 2

Sodium Silicate Bead Tests in Qualitative Analysis

Midgley, C. P.

J. Chem. Educ. 44,483 (1967)

Without heating, mixing of sodium silicate solutions with transition metal ions as salts gives characteristic color. Substitutes for borax bead test.

*ANAL APPARATUS BIOCHEM ELECTRODE ENZYME INSTR TECHNIQUE 4

Determination of Penicillin Using an Immobilized Enzyme Electrode

An Undergraduate Experiment

Mifflin, T. E.; Andriano, K. M.; Robbins, W. B.

J. Chem. Educ. 61,638 (1984)

Penicillinase is immobilized on a glass electrode in a polyacrylamide matrix. The relatively inexpensive electrode can be constructed in one 3-hr. lab. and calibrated and utilized for detn. of penicillin in a second period.

*ANAL ENVIRON FLUOR WATERCHEM 2

Fluorimetric Analysis of Nitrate in Real Samples

Miguel, A. H.; Braun, R. D.

J. Chem. Educ. 51,682 (1974)

Spectrofluorimeter, quartz cell, fluorescein. Analysis of soil, river water, fertilizer samples. Requires work with approx. 50 ml of conc. sulfuric acid. Caution: conc. H₂SO₄ is a health hazard (burns).

*ANAL GC INSTR 3

Dual Column Gas Chromatography: A teaching tool

Miller, J. M.

J. Chem. Educ. 41,413 (1964)

Use of two different columns in a dual column gc shows effects of retention time, loading, homologous series.

*ANAL CONSUMERPROD ENVIRON GC 2 3

Gas Chromatographic Analysis of Aerosol Propellants

Miller, J. M.

J. Chem. Educ. 54,735 (1977)

Most contain several components. Simple gc can detect different fluorocarbons, hydrocarbons, nitrous oxide.

*ANAL CONSUMERPROD UVIS 2

An Introductory Experiment on Phosphates in Detergents

Mohrig, J. R.

J. Chem. Educ. 49,15 (1972)

Spec-20. Two methods: (1) vanadomolybdic, (2) molybdenum blue formation. Reagents: ammonium molybdate and vanadate, 1-amino-2-naphthol-4-sulfonic acid (an antifoaming agent). Commercial detergents.

*ANAL BIOCHEM GELC NOPROC TECHNIQUE TLC 3 4

Thin-Layer Gel Permeation Chromatography:

A Technique to Separate Molecules According to Molecular Size

Moir, N. J.

J. Chem. Educ. 60,430 (1983)

Note describes the technique of TLGPC including preparation of the plates and application to protein analysis. The technique appears simple and widely applicable.

*ANAL CONSUMERPROD TITN UVIS 2

Determination of Phosphoric Acid in Cola Beverages; A Colorimetric and pH

Titration Experiment for General Chemistry

Murphy, J.

J. Chem. Educ. 60,420 (1983)

Colorimetric (using ammonium molybdate/ammonium vanadate reagent at 400 nm) and pH titn. methods are compared in a simple analysis of interesting samples.

*ANAL INORG CORROSION QUAL REDOX 2

Additional Reactions of the Ferroxy Indicator

Myers, R. T.; Falcone, R. E.

J. Chem. Educ. 49, 599 (1972)

Ferroxy reagent = $K_3Fe(CN)_6$ + phenolphthalein in agar gel. There is slow diffusion, allowing study of slow reactions by colors of zones and changes with time. Article describes simple iron corrosion study.

*ANAL BIOCHEM CHROMATOG IONX NATPROD PROJ TLC UVIS 3

Laboratory Experiments Using Nicotine

Navari, R. M.

J. Chem. Educ. 51, 748 (1974)

Determination of nicotine in tobacco, blood, and urine. Caution: blood is an infection hazard, and pure nicotine is highly toxic and absorbs through the skin. Detailed presentation.

*ANAL QUAL 2

Dodecyl Sodium Sulfate as a Reagent for the Detection of Potassium

Neman, R. L.

J. Chem. Educ. 44, 479 (1967)

Potassium salt is sufficiently insoluble to be used as a qual. test for potassium ion. Modified Group V scheme.

*ANAL PHARM TLC 4

The Thin-Layer Chromatography of Drugs: A Laboratory Experiment

Neman, R. L.

J. Chem. Educ. 49, 834 (1972)

Explicit procedure. Methadone, morphine, barbiturates analyzed by silica gel TLC. Visualization by UV and spraying with iodoplatinate and ammoniacal $AgNO_3$. (Caution: storage hazard). Study questions. Warning: controlled substances.

*ANAL ORG GC PHARM 3

Gas-Liquid Chromatography of Derivatized Barbiturates

Novotny, M.; Bartle, K. D.

J. Chem. Educ. 51, 333 (1974)

Methylating agent: trimethylanilinium hydroxide. Hewlett-Packard #700/HC. Caution: controlled substances.

*ANAL MASSPEC 4

The Determination of the Natural Abundance of the Isotopes of Chlorine:

An Introductory Experiment in Mass Spectrometry

O'Malley, R. M.

J. Chem. Educ. 59, 1073 (1982)

For 4th year students. Students obtain mass spectrograms of dichloromethane, trichloroethylene, tetrachloroethylene, and 1,1,2-trichloro-1,2,2-trifluoroethane. CAUTION: halogenated organics, cancer suspect agents. Complete spectra and detailed interpretation.

*ANAL DRYLAB FLUOR INSTR QUANTUM 4

Quinine Fluorescence Spectra: A Dry-lab Spectral Analysis Experiment

O'Reilly, J. E.

J. Chem. Educ. 53, 191 (1976)

Experiment consists in assigning the various peaks in the spectra to some basic physical, chemical or instrumental cause. Students are provided with excitation and emission spectra of quinine in dil. sulfuric acid.

*ANAL CONSUMERPROD FLUOR NATPROD 2

Fluorescent Experiments with Quinine

O'Reilly, J. E.

J. Chem. Educ. 52, 610 (1975)

Spectrophotometer. Quinine in soft drinks, urine, etc. Straightforward.

*ANAL CONSUMERPROD IONSELECT 4

Determination of Iodide in Milk with an Ion Selective Electrode

O'Reilly, J. E.

J. Chem. Educ. 56, 279 (1979)

Method of standard additions. Electrodes are slow to equilibrate at low concentration.

*ANAL ORG CONSUMERPROD NOPROC TLC 2 3

Identification of Unknown Black Inks by Thin-Layer Chromatography

Olesen, B.; Hopson, D.

J. Chem. Educ. 60, 232 (1983)

Authors describe this as an introductory organic lab experiment, but it could be used at any level. Ball point, felt tip, and other inks are included; two solvent systems are used. Dyes are not identified but R_f values are given in this note. HVCC places this at first semester of a non-chem majors lab with good results.

*ANAL EDTA TITN UVIS 4

Automated Spectrophotometric Titrations

Olsen, E. D.; Foreback, C. C.

J. Chem. Educ. 49,206 (1972)

EDTA titration of Ba++, Cu++, Sb+3, Fe+3 to Eriochrome Black T with a titrator made from a Spec-20, drop-counter and recorder.

*ANAL BIOCHEM IONX NATPROD QUAL WATERCHEM 2

Semi-micro Ion-exchange in the Freshman Laboratory

Olson, M. V.; Crawford, J. M.

J. Chem. Educ. 52,546 (1975)

Biorad #731-1220 disposable columns (reusable). Blood, plasma, sea water, std. quant. unkns. Caution: blood is an infection hazard.

*ANAL APPARATUS ENVIRON GRAVIM UVIS 2

The Determination of Nitrogen Oxide and Particulates in Cigaret Smoke

A Student Laboratory Experiment

Ondrus, M. G.

J. Chem. Educ. 56,551 (1979)

Cigaret smoke is sampled using a membrane filter and large syringe.

Particulates determined by increase in weight of filter; nitrogen oxides by reaction with sulfanilic acid and N-(1-naphthyl)ethylenediamine forming a pink color which can be determined spectrophotometrically. Spec-20. Standard nitrite solution.

*ANAL ORG CONSUMERPROD HPLC 3

Sugar Determination in Foods with a Radially Compressed High Performance

Liquid Chromatography Column

Ondrus, M. G.; Wenzel, J.; Zimmerman, G. L.

J. Chem. Educ. 60,776 (1983)

Waters radial compression system strongly recommended for student use.

Samples include soft drinks, cereals, dairy products (different sample preparations required); standards are fructose, glucose, sucrose, lactose.

Column is silica treated with tetraethylenepentamine, mobile phase is alkaline acetonitrile-water.

*ANAL GC QUANT 3 HAZARD

Quantitative Gas Chromatography Using Peak Heights and Relative

Response Factors: An Undergraduate Student Experiment

Pacer, R. A.

J. Chem. Educ. 53,592 (1976)

Toluene, benzene and p-xylene mixtures chromatographed under conditions which give sharp, well-defined peaks, to determine relative response factors. From this calibration, unknown mixtures may be analyzed.

1% accuracy reported. HAZARD: avoid benzene.

*ANAL DISTRIB UVIS 3

A Laboratory Experiment with Dyes to Illustrate Countercurrent Distribution

Padilla, B. A.; Herran, J.

J. Chem. Educ. 39,539 (1962)

Countercurrent distribution illustrated with 6 separatory funnels, phenol red and bromocresol green, water-1-butanol and sodium carbonate. Or with 29 funnels and colorimeter.

*ANAL APPARATUS ELECTRODE IONSELECT PROJ 2 3

Fabrication of an Inexpensive Ion-Selective Electrode

Palanivel, A.; Riyazuddin, P.

J. Chem. Educ. 61,920 (1984)

Graphite rods extracted from used dry cells are used to prepare Ag₂S/CuS electrodes. Written for instructor, but preparation easily done by students. Not an expt., but could well be a part of an experiment involving an application. Other types of sensors can also be constructed. A good project.

*ANAL APPARATUS ELECTROANAL INSTR IONSELECT 3 4

Construction and Evaluation of a Solid-State Iodide Selective Electrode:

A chemical instrumentation laboratory experiment

Papastathopoulos, D. S.; Karayannis, M. I.

J. Chem. Educ. 57,904 (1980)

Describes construction and calibration of simple crystalline homogeneous membrane electrode using pellet (pressed in KBr die) of coprecipitated silver iodide/sulfide. Cheap, easy to make.

*ANAL GC QUANT STATISTICS 4

Quantitative Gas Chromatography: An experiment

Pardue, H. L.; Burke, M. F.; Barnes, J. R.

J. Chem. Educ. 44,695 (1967)

Hydrocarbon separation; analysis by integration. Basics of circuits for automation included; modern instrumentation has this.

*ANAL PHYS APPARATUS BIOCHEM ENZYME KIN REDOX 4

Reaction Rate Analysis and Instrumentation: An experiment for the analytical laboratory

Pardue, H. L.; Burke, M. F.; Jones, D. O.

J. Chem. Educ. 44,684 (1967)

Determination of glucose by enzymatic oxidation yielding H₂O₂, which is detd iodometrically. Requires special stirred cell and monitoring current of rotating platinum electrode. Reader (DT) points out reaction is
 $\text{RCHO} + \text{O}_2 + \text{H}_2\text{O} = \text{RCOOH} + \text{H}_2\text{O}_2$

*ANAL DISTRIB 3 HAZARD

Cupferron as a Reagent in Quantitative Analysis

Parks, A. O.; DuBose, R.

J. Chem. Educ. 46,768 (1969)

Experiment devised before cupferron/ CHCl_3 extraction was known to be a health hazard (carcinogen).

*ANAL AA-FP CONSUMERPROD NOPROC 3

An Atomic Absorption Experiment in Food Chemistry

Paschal, D. C.

J. Chem. Educ. 53,165 (1976)

Manganese and zinc in cat food analyzed.

*ANAL INORG QUAL REVIEW 2

Qualitative Test for Potassium Using Sodium Tetraphenylboron

Paul, A. D.; Gibson, J. A., Jr.

J. Chem. Educ. 36,380 (1959)

Research report. The reagent is claimed to be superior to cobaltinitrite for student use. 22 references.

*ANAL QUAL 2

Detection of Chloride Ion in the Presence of Bromide, Iodide, and Thiocyanate Ions

Paul, A. D.; Gibson, J. A., Jr.

J. Chem. Educ. 42,440 (1965)

Research report and development of a new method - Na_2SO_3 reduces Cu(II) to Cu(I) . This precipitates iodide and thiocyanate but not chloride.

*ANAL QUAL 2

Qualitative Analysis for Aluminum

Paul, A. D.; Gibson, J. A., Jr.

J. Chem. Educ. 39,398 (1962)

Refined procedure using morin avoids interferences which are otherwise a major problem. "Morin" is an organic pptg agent.

*ANAL ORG CONSUMERPROD GC NATPROD 3

The Fatty Acid Composition of Edible Oils and Fats: A Beginning GLC Experiment

Paulson, D. R.; Sarento, J. R.; Forman, W. A.

J. Chem. Educ. 51,406 (1974)

Samples of C(17) to C(20) aliphatic acids co-injected as the methyl esters (obtained by BF_3 -catalyzed transesterification) with methyl heptadecanoate. Caution: BF_3 (toxic).

*ANAL ORG ASPIRIN PHARM TLC 3 HAZARD

TLC Detection of Caffeine in Commercial Products

Pavlik, J. W.

J. Chem. Educ. 50,134 (1973)

Silica gel TLC plates. 8 appropriate solvent systems. Anacin, APC, Bufferin, Excedrin, Nodol, etc. Hazard: avoid the use of benzene and chloroform (carcinogens) even on a micro scale.

*ANAL ORG PREP UVIS 3

Two Nitrosophenol Reagents for Iron(II) and Cobalt.

Peach, S. M.

J. Chem. Educ. 42,437 (1965)

Dinitrosoresorcinol, sodium sulfonate and nitroso-4-chlororesorcinol are prepared and used in colorimetric analysis. Good combination of organic-analytical, simple preparation.

*ANAL ACBA CONSUMERPROD GAS 1 2

Bicarbonate in Alka-Seltzer: A general chemistry experiment

Peck, L.; Irgolic, K.; O'Connor, R.

J. Chem. Educ. 57,517 (1980)

A change of pace for gas-law lab. Seems more relevant. CO_2 is collected over water, illustrating stoichiometry as well as general gas law and partial pressures. Quick, after setup, allowing for multiple determinations.

*ANAL UVIS 2

The Turbimetric Determination of Lead

Perkins, G., Jr.; Wimberley, J. W.; Lamb, J. F.; Maurer, L. E.

J. Chem. Educ. 38,358 (1961)

Spec-20 or Duboscq colorimeter. Rgnt: ammonium molybdate. Comparison standard: thymol blue. Caution: lead is an embryotoxin.

*ANAL COMPUTER GC INSTR 4

On-Line Digital Computer Applications in Gas Chromatography: An undergraduate analytical experiment

Perone, S. P.; Eggleston, J. F.

J. Chem. Educ. 48,438 (1971)

Exercise in interfacing a computer with a gas chromatograph. Program in BASIC given.

*ANAL INORG QUAL 1 HAZARD

A Spot Test for Cadmium

Petroccione, J. F.

J. Chem. Educ. 35,402 (1958)

Cd++ can be detected in the ammoniacal solution with Titan Yellow. Cu++ does not interfere. This test was developed for high school students.

HAZARD: avoid cadmium.

*ANAL ORG PHYS KIN REDOX UVIS 4

Periodate Oxidation of Vicinal Hydroxyls. Applications to Student Experiments

Pilch, P. F.; Somerville, R. L.

J. Chem. Educ. 54,449 (1977)

Periodate oxidations may be easily followed (Spec 20) in that unreacted periodate will rapidly bleach the violet compound ferrous 2,4,6-tri-2-pyridyl-s-triazine to a colorless compound. Second order plots of two such oxidations are given. Other experiments are suggested.

*ANAL COLUMN GC TLC 3 HAZARD

Separation by Adsorption Chromatography: An experiment on a colorless mixture

Pine, S. H.

J. Chem. Educ. 43,672 (1966)

Dry-pack column, TLC or GC to separate 1-phenylethanol and acetophenone.

HAZARD: chloroform (carcinogen), avoidable.

*ANAL ORG FORENSIC GC IR NMR PREP SEQ 4

A Benzidine Rearrangement and the Detection of Trace Quantities of Blood.

A Laboratory Experiment in Criminalistics.

Pinkus, J. L.; Goldman, L. S.

J. Chem. Educ. 54,380 (1977)

3,5,3',5'-tetramethylbenzidine prepared from 2,6-dimethylaniline in 3-step synthesis used as a reagent for blood, avoids carcinogenic compounds.

Caution: blood is an infection hazard.

*ANAL AA-FP 2

Determination of Iron by Atomic Absorption in Vitamin-Mineral Tablets

Pinnell, R. P.; Zanella, A. W.

J. Chem. Educ. 58,444 (1981)

Straightforward. Students enthusiastic because it's relevant.

*ANAL ASPIRIN IONX PHARM UVIS 3

Quantitative Analysis of APC Tablets: An Easy Experimental Method Based on the Use of Ion-Exchange Resins.

Pisani, G. F.

J. Chem. Educ. 53,733 (1976)

Anion exchange resin will retain acetylsalicylic acid much more strongly than phenacetin and caffeine. Fraction collector. UV-spectrophotometric analysis of eluate fractions.

*ANAL AA-FP NATPROD 3 HAZARD

The Determination of Zinc in Hair Using Atomic Absorption Spectroscopy

Pomeroy, R. K.; Dritakis, N.; Koga, Y.

J. Chem. Educ. 52,544 (1975)

Detailed directions for sample preparation and atomic absorption spectroscopy. Hazard: org. sample (hair) decomposed in hot, conc. perchloric-nitric acid mixture. Explosion hazard.

*ANAL INORG PAPER GC 2 HAZARD

Paper Chromatography and Spot Tests: A useful combination of techniques

Poonia, N. S.

J. Chem. Educ. 43,423 (1966)

Radial disk paper chromatography of anions and cations. HAZARD: chloroform in developing solvent is a carcinogen; replace.

*ANAL QUAL 3

Detection of Iron with Salicylimine

Poonia, N. S.; Bakre, V. P.; Bal, M. S.

J. Chem. Educ. 44,483 (1967)

Spot test - improved sensitivity for both Fe(II) and Fe(III).

*ANAL QUAL 3

Spot Tests for Silver (I) and Manganese (II)

Poonia, N. S.; Gupta, H. K. J.

J. Chem. Educ. 44,480 (1967)

Piperidine enhances formation of black or colored spot test from dilute manganese(II) and silver salt solutions.

*ANAL PAPER QUAL 2

Piperidine-A Spot Reagent for Mn(II)
Poonia, N. S.; Gupta, H. K. L.
J. Chem. Educ. 42,438 (1965)
Spot tests on filter paper strips.

*ANAL INORG QUAL 2

Separation and Identification of Copper and Cadmium
Poonia, N. S.; Gupta, H. K. L.
J. Chem. Educ. 41,439 (1964)
3 semi-micro procedures for the quantitative wet separation of Cu and Cd using organic precipitating reagents. Hazard: Cd (toxic)

*ANAL POLYMER APPARATUS COMPUTER IR NOPROC 4

Laboratory Automation in the Undergraduate Curriculum:
Determination of polyethylene chain branching by computerized IR methods
Powers, D. E.; Harris, W. C.; Kalasinsky, V. F.
J. Chem. Educ. 56,128 (1979)
Computer-interfaced IR for analysis

*ANAL ORG ACBA ASPIRIN ELECTROANAL PHARM 2

Analysis of Aspirin: a Conductometric Titration
Proctor, J. S.; Roberts, J. E.
J. Chem. Educ. 38,471 (1961)
Titr. with std. base assuming acetylsalicylic acid is total acid. Simple conductance bridge. Children's aspirin, etc.

*ANAL INORG DEMO GRAVIM 3

Precipitation of Lead Chromate from Homogeneous Solution: A Lecture Demonstration or a Laboratory Experiment
Ramette, R. W.
J. Chem. Educ. 49,270 (1972)
Chromate is generated by oxidation of Cr(III) with bromate. Demo shows slow pptn. yields filterable crystals, in contrast to simple mixing of reactants.

*ANAL EDTA 4 HAZARD

EDTA Titration of Cadmium and Mercury: An Exercise in Logic.
Ramsay, C. G.
J. Chem. Educ. 54,714 (1977)
Cd++ and Hg++ can be determined by reacting with an excess of EDTA and back-titrating with Zn++. Experiment investigates use of masking reagents to permit individual determination of these species. Optimum conditions for masking are determined.
HAZARD: Cd++ and Hg++ solutions are toxic.

*ANAL GC NATPROD QUAL 3 4 HAZARD

Qualitative Analysis by Gas Chromatography
GC versus the Nose in Formulating Artificial Fruit Flavors
Rasmussen, P. W.
J. Chem. Educ. 61,62 (1984)
GC retention indices are used to identify various volatile components in a banana. Prepn. of sample and standards involves steam distn., extraction, ester synthesis. Extensions involve nmr, ir,ms, prepn. of artificial banana flavor, and comparison with commercial artificial flavor. Many periods.
HAZARD: CH₂Cl₂ is a probable carcinogen.

*ANAL COMPUTER INSTR QUANT TECHNIQUE UVIS 3 4

Optimal Multicomponent Analysis Using the Generalized Standard Addition Method
Raymond, M.; Jochum, C.; Kowalski, B. R.
J. Chem. Educ. 60,1072(1983)
This new technique is illustrated by the spectrophotometric analysis for chromium and manganese in a solution containing dichromate and Mn+2. Eliminating the preparation of calibration curves saves experimental time and "matrix effect" errors. A computer program (Fortran and/or HP-41C) commercially avail. saves some lengthy plotting for calculations.

*ANAL TECHNIQUE UVIS 3

A Unique Approach to Teaching Spectrophotometric Procedures
Reeves, R. R.; Hutson, M. D.; Williams, H. P.
J. Chem. Educ. 52,659 (1975)
Directed only toward learning techniques. Mixtures of food colors and clothing dyes make artificial unknowns for choosing conditions for analysis. Like most "technique" experiments, it is not very stimulating.

*ANAL EDTA REVIEW TECHNIQUE TITN '3

Chelon Approach to Analysis: II. Illustrative experiments

Reilley, C.; Schmid, R. W.; Sadek, F.

J. Chem. Educ. 36,619 (1959)

14 experiments are described (in varying amounts of detail) for the determination of various metal ions by EDTA titration. Masking techniques are described, and various methods of separation are employed before titration. Details of solution preparation are given. There is sufficient detail for an upperlevel undergraduate to perform the experiments, but not for a freshman.

*ANAL AA-FP NATPROD PROJ 3

Strontium and Zinc Content in Bones as an Indication of Diet: An Undergraduate Project in Quantitative Analysis with Interdisciplinary Interest

Rheingold, A. L.; Hues, S.; Cohen, M. N.

J. Chem. Educ. 60,233 (1983)

Explicit procedure includes method of pretreatment of fresh bones. CONTAG-ION WARNING. Straightforward otherwise.

*ANAL NOPROC QUAL 2

New Confirmatory Tests for Manganese, Antimony, Lead, Mercury, and Chromium

Rich, R.

J. Chem. Educ. 39,400 (1962)

Improvements or improved alternatives suggested.

*ANAL QUAL 2

The Cyanocobaltate Scheme of Qualitative Analysis

Rich, R.

J. Chem. Educ. 39,403 (1962)

Novel scheme for Na, K, Mg, Ca, Sr, Ba, Ti, Cr, U, Mn, Fe, Co, Ni,

Cu, Ag, Zn, Cd, Hg, Al, Sn, Pb, Sb, Bi.

*ANAL IONX QUAL SOLUB 2

Dissolving Difficultly Soluble Salts with Chelating Ion Exchange

Resins

Rich, R.

J. Chem. Educ. 40,414 (1963)

Research report. Mix finely ground salt with resin (aq) and allow to stand.

Dissolving times (remarkably short) given for 12 common insol.salts, e.g.,

BaSO₄.

*ANAL QUAL 1 2 HAZARD

Qualitative Analysis, with Periodicity, for "Real" Solutions

Rich, R. L.

J. Chem. Educ. 61,53 (1984)

Two new, non-H₂S qual schemes are explained in detail. The bromide scheme relates well to the periodic table. Realistic unknowns can be used because most substances are non-interfering. The iodide scheme is a simplified version, emphasizing nutritionally important metals and environmental hazards. HAZARD: CH₂Cl₂ is a probable carcinogen.

*ANAL INORG QUAL 1 HAZARD

A Laboratory Exercise Emphasizing Deductive Chemical Reasoning

Ricketts, J. A.

J. Chem. Educ. 37,311 (1960)

Qual. techniques and logic exemplified with a simplified set of cations, viz. silver(I), mercury(I), cadmium, aluminum, and barium. HAZARD: avoid cadmium.

*ANAL ACBA ELECTROCHEM ELECTRODE NOPROC PH 2

Acid-Base Titrations with the Tellurium Electrode

Ricketts, J. A.; Bowen, R. E.

J. Chem. Educ. 37,473 (1960)

An experiment is described where the student simultaneously titrates an acid with a base using 1) a tellurium-tellurium oxide electrode and 2) an ordinary glass electrode.

*ANAL APPARATUS ELECTRODE ENZYME INSTR TECHNIQUE 4

A Gas-Sensor-Based Urea Enzyme Electrode

Its Construction and Use in the Undergraduate Laboratory

Riechel, T. L.

J. Chem. Educ. 61,640 (1984)

An ammonia electrode (commercial) is easily converted to an immobilized enzyme urea electrode by physical entrapment of urease on the tip of an ammonia gas sensor. This clinically important analysis is good in an instrumental course designed for students in health related sciences. Requires two periods.

*ANAL PAPER QUAL 3 HAZARD

A Paper Chromatographic Scheme for the Identification of Metal Ions

Ritchie, A. S.

J. Chem. Educ. 38,400 (1961)

Elaborate scheme using four developing solvents to give R_f "profiles" characteristic of ions. HAZARD: two of the solvents include small amounts of conc. HF (can cause serious skin damage). Ions also detected by reagents.

*ANAL ORG DEMO NATPROD TLC 1 2 HAZARD

Thin Layer Chromatographic Separation of Leaf Pigments: A rapid demonstration

Rollins, C.

J. Chem. Educ. 40, 32 (1963)

Quick, straightforward. See Anwar, M.H., J. Chem. Educ. 40, 29(1963).

HAZARD: benzene (carcinogen), avoidable.

*ANAL ORG IONX ISOMERS UVIS 5

Separation of Bromoaniline Isomers by Cation-Exchange Chromatography.

Romano, S. J.

J. Chem. Educ. 47, 478 (1970)

Sephadex C-25 CM, macro and micro columns, 10-mm flow cell.

Packing details but little other procedure given.

*ANAL ORG ASPIRIN FORENSIC PHARM TLC 3

An Organic Chemistry Experiment for Forensic Science Majors

Rothchild, R.

J. Chem. Educ. 56, 757 (1979)

Extraction of components of over-the-counter analgesics and their safe TLC analysis with non-carcinogenic solvents. Suggested procedure only.

*ANAL COLLIG FORENSIC PHARM TECHNIQUE 3

A Forensic Science Laboratory Experiment: Molecular Weights of Drugs and Diluents by Osmometry

Rothchild, R.

J. Chem. Educ. 59, 672 (1982)

Use of an automatic osmometer (freezing point depression) to analyze confiscated street drugs. Straightforward.

*ANAL ORG COLUMNC 3

A Laboratory Introduction to Quantitative Column Chromatography

Rubinson, J. F.; Rubinson, K. A.

J. Chem. Educ. 57, 909 (1980)

Students analyze unknown mixture of bromocresol green and methyl orange using a silica gel column, ethyl acetate as the moving phase, and quantitative analysis of the eluates with Spec 20's. Requires the preparation of a Beer's Law plot for both species. Straightforward; suitable for large classes.

*ANAL GC INSTR 4

Gas Chromatographic Determination of Environmentally Significant Pesticides

Rudinski, W. E.; Beu, S.

J. Chem. Educ. 59, 614 (1982)

Spiked orange juice extracted to yield dry hexane solution; pesticides adsorbed on Florisil (expensive) column, eluted, and samples analyzed by flame ionization or electron capture GC. Detailed, straightforward. No hazard analysis. Warning: pesticides are highly toxic.

*ANAL AA-FP INSTR STATISTICS 4

Performance Characterization of an Instrument

Salin, E. D.

J. Chem. Educ. 61, 70 (1984)

Atomic emission with digital readout is used to involve students with concepts of detection limit, signal to noise ratio, dynamic range, and linear dynamic range. Step by step procedure for determination of experimental noise sources. Applicable to other instrumentation.

*ANAL INORG QUAL 2 HAZARD

Separating Copper from Cadmium Without Cyanide

Sanyal, S.

J. Chem. Educ. 36, 387 (1959)

Short note. Sep'n is by extraction of Cd++ from mixed sulfide ppt. with dilute H2SO4. HAZARD: avoid cadmium.

*ANAL COLORIMETRY ENVIRON TITN WATERCHEM 2

A Study of Water Pollution - An undergraduate laboratory experience.

Sarkis, V. D.

J. Chem. Educ. 51, 745 (1974)

Hach (direct reading) colorimetric unit used for inorganic constituents.

Based on American Public Health methods.

*ANAL KSP SOLUB 2

Solubility and Ksp of Calcium Sulfate:

A General Chemistry Laboratory Experiment

Sawyer, A. K.

J. Chem. Educ. 60, 416 (1983)

Direct measurement of amt of CaSO4 in a saturated solution by weighing a beaker before and after evaporating an aliquot to dryness on a hot plate. Designed to teach balance, pipetting techniques. A first experiment.

*ANAL ORG TITN 4

Periodate Cleavage of Glycols: A quantitative organic analysis experiment
Schenk, G. H.
J. Chem. Educ. 39,32 (1962)
Periodic acid is standardized with sodium arsenite - iodine. Extension:
study pH profile (time of reaction).

*ANAL COLUMNC COORD UVIS 3

Column Chromatography and Spectrophotometry for Separating Two Cobalt Complexes
Schmitt, D. L.; Jonassen, H. B.
J. Chem. Educ. 46,47 (1969)
Small silica gel column. Elution with water separates $(\text{Co}(\text{NH}_3)_5\text{Cl})\text{Cl}_2$ and $(\text{Co}(\text{NH}_3)_6)\text{Cl}_3$, but not very well. Analysis by visible spect.
Refers earlier article on prepn. and spectroscopy.

*ANAL APPARATUS DEMO PH TITN 2

Comparison of Strong Acid and Weak Acid Titration Curves.
Schultz, C. W.; Spannuth, S. L.
J. Chem. Educ. 56,194 (1979)
Apparatus for plotting acid/base titration curves using readily available lab equipment described.

*ANAL COORD ELECTROANAL KEQ STOICH 4

Stoichiometry and Formation Constant Determination
Schultz, F. A.
J. Chem. Educ. 56,62 (1979)
 $\text{Pb}(\text{II})$ -oxalate forms two complexes, one soluble. Analysis of polarographic results is not simple.

*ANAL ELECTROCHEM ELECTRODE TITN 4

A Student Constructed Potentiometric Electrode and Semi-auto Titrator System
Seemuth, D. P.; Hall, J. L.; Robertson, K. A.; Huber, C. O.
J. Chem. Educ. 56,65 (1979)
Details of construction of lead-dioxide electrode given and its use in acid-base titration described.

*ANAL INSTR TITN UVIS 3 4

Analysis of Tartar Emetic: A photometric titration
Sellers, D. E.; Tang, S. S. N.; VanAtta, R. E.
J. Chem. Educ. 39,408 (1962)
 KMnO_4 titration with spectroscopic (colorimetric) endpoint. Semimicro buret, stirred cell or manual stirring. Anal. of results of 23 expts.

*ANAL NATPROD PROJ REDOX 2 HAZARD

The Determination of Iodide in Seaweed: A General Chemistry Research Experience
Senyk, J. I.
J. Chem. Educ. 54,511 (1977)
A project to determine the best method of solution and titrimetric determination of iodine in sea weed. All methods involve the oxidation of iodide to iodine, extraction into chloroform (HAZARD: carcinogen; substitute dichloromethane) and subsequent titration with thiosulfate. For very small classes.

*ANAL DRYLAB INSTR PROJ 4

Project Select: An assignment in instrument evaluation for undergraduate analytical students
Settle, F. A.
J. Chem. Educ. 56,411 (1979)
Hypothetical analytical situation as in a commercial analytical lab plus manufacturers' literature. Select instrument. Sample questions given.

*ANAL TECHNIQUE UVIS 3

Simplex Optimization of Chemical Systems
Shavers, C. L.; Parsons, M. L.; Deming, S. N.
J. Chem. Educ. 56,307 (1979)
Systematic variation of amounts of reagents in developing a color test, together with the simplex (theory explained) treatment to optimize the reaction conditions.

*ANAL FORENSIC 1 2 HAZARD

Human Blood Identification: A Forensic Science Approach
Sheehan, F. X.; Kobilinsky, L.
J. Chem. Educ. 61,542 (1984)
A series of experiments (minimum five 45-min. periods, two more for unknowns) designed for forensic science courses, but also of general interest. A stained fabric is analyzed to determine if blood is present and, if so, whether of human origin. Controls, confirmatory tests, species tests clearly described. Directions for minimizing HAZARD (human blood). Instructor knowledge of serology helpful.

***ANAL ORG ASPIRIN PH TITN 2**

Potentiometric Titration of Aspirin in Ethanol

Shen, S. Y.; Gilman, A. J.

J. Chem. Educ. 42,540 (1965)

pH meter, titrant: alcoholic KOH. Non-aqueous pot. tit'n with glass electrode.

***ANAL COORD DEMO IONX PAPER PROJ 2**

Ion-Exchange Papers

Sherma, J. A.

J. Chem. Educ. 39, A83 (1962)

Separation of iron(III) nitrate and cobalt(II) chloride on ion exchange paper. Others suggested.

***ANAL ACBA GRAVIM IONX STOICH TITN 2**

The Stoichiometry of Hydrated Copper Sulfate: A general chemistry laboratory experiment

Silber, H. B.

J. Chem. Educ. 49,586 (1972)

Cu++ by tit'n of H+ released from ion-exchanger. SO₄(=) as BaSO₄. Water by difference. BaSO₄ weighed on dried filter paper.

***ANAL ACBA GRAVIM IONX PROJ STOICH TITN 4**

The Analysis of an Unknown Lanthanide Salt: A set of analytical experiments

Silber, H. B.

J. Chem. Educ. 50,720 (1973)

La+++ by tit'n of H+ released from ion-exchanger. La+++ also gravimetric by oxalate and volumetric as oxalate-permanganate titn. Student is issued an unknown La(III) salt for total analysis. About 4 lab periods.

***ANAL HPLC NATPROD QUANT 3**

HPLC Analysis of Chlorophyll a, Chlorophyll b, and beta-Carotene in Collard Greens; A Project for a Problem-Oriented Laboratory Course

Silveira, A., Jr.; Koehler, J. A.; Beadel, E. F., Jr.; Monroe, P. A.

J. Chem. Educ. 61,264 (1984)

Extraction of collard greens or spinach with methanol-isooctane or SEP-PAK (TM), and HPLC separation and quantitative analysis takes only about 25 minutes. Should be considered along with or in place of column or TLC.

***ANAL ORG TLC 3**

Determining the Molecular Weight of Normal Fatty Acids by Thin Layer Chromatography

Singh, E. J.; Zuspan, F. P.

J. Chem. Educ. 50,625 (1973)

Silica gel R_f values of straight-chain carboxylic acids are a linear function of molecular weight. Visualization by spraying with dilute chromic acid. Moving phase is water sat'd butanol. Caution: avoid inhaling chromic acid dust (causes severe lung damage).

***ANAL BIOCHEM ELECTROANAL ENZYME INSTR 4**

Amperometric Determination of Glucose at Parts Per Million Levels with Immobilized Glucose Oxidase: An Undergraduate Experiment

Sittampalam, G.; Wilson, G. S.

J. Chem. Educ. 59,70 (1982)

Detailed procedure with drawings for enzyme immobilization; complete procedure for amperometric analysis. A technique much used in clinical laboratories.

***ANAL PAPER QUAL 2**

The Paper Chromatographic Separation of the Ions of Elements 26 Through 30: A laboratory experiment

Skovlin, D. O.

J. Chem. Educ. 48,274 (1971)

Elements spotted as chlorides. Moving phase 2-butanone. Visualization by spot reagents. Within capacity of many high school students.

***ANAL INORG COORD ELECTROANAL STOICH TITN UVIS 2**

Composition of Metal Ammine Ions

Slabaugh, W. H.

J. Chem. Educ. 42,470 (1965)

Short note: potentiometric titration (Ag+), photometric titration (Cu++).

Metal ions are titrated with aq. NH₃. Caution: do not store Ag+-NH₃ solns.

***ANAL NOPROC UVIS 2**

Recreating Some Early Work in Chemical Spectroscopy: A Freshman Chemistry Laboratory Exercise

Smedley, L. C., Jr.

J. Chem. Educ. 59,24 (1982)

Short note describes teaching absorption and emission line spectra following actual work of Bunsen and Kirchhoff. Student handout available by writing, for two-period expt. including purific. barium chloride. Ba++ emission, flame spectra of known and unknown solar spectrum, etc. Prism spectrometer.

*ANAL APPARATUS ELECTROANAL 4

A Comprehensive Experiment in Electroanalytical Chemistry
Smith, D. M.

J. Chem. Educ. 49,87 (1972)

A modular electrochem unit incorporates a polarograph, potentiometer, pH meter, chronopotentiometer, constant voltage supply, etc. One example procedure in detail: coulometric titration of As(III) with I⁻.

*ANAL CALORIMETRY EDTA INSTR THERMO TITN 4

The Quantitative Resolution of a Mixture of Group II Metal Ions by Thermometric Titration with EDTA; An Analytical Chemistry Experiment
Smith, R. L.; Popham, R. E.

J. Chem. Educ. 60,1076(1983)

Research grade calorimeter and strip chart recorder are required. A mixture of Ca⁺⁺, Mg⁺⁺, and Ba⁺⁺ is resolved. Explicit procedure.

*ANAL ENVIRON REDOX TITN WATERCHEM 2 HAZARD

Dissolved Oxygen: A Relevant Experiment for the Introductory Laboratory.

Stagg, W. R.

J. Chem. Educ. 49,427 (1972)

O₂ from air absorbed in alkaline Mn(II); iodometric titration. HAZARD: sodium azide, used to scavenge nitrite, is toxic and a storage hazard.

*ANAL ACBA REDOX STOICH TITN 2

Writing a Chemical Equation from Titration Data: Experiment for general chemistry

State, H. M.

J. Chem. Educ. 39,297 (1962)

Analyzed solutions of NaOH and H₃PO₄ titrated to two different indicators to allow students to find stoichiometric factors. Similarly, previously analyzed solution of aq. I₂ titrated w. std thiosulfate to starch endpoint. Minimal directions.

*ANAL ORG TITN 3

Molecular Weight Determination of Aldehydes and Ketones:

A Quantitative Organic Experiment

Steinhaus, R. K.

J. Chem. Educ. 50,293 (1973)

Acid hydrolysis of semicarbazone gives semicarbazide. This can be titrated with N-bromosuccinimide. Complete procedure given.

*ANAL AA-FP 3 HAZARD

Determination of Blood Levels in the Analytical Laboratory

Stemporzewski, S. E.; Butler, R. A.; Barry, E. F.

J. Chem. Educ. 53,516 (1976)

Lead in blood by atomic absorption. HAZARD: how to get blood from humans without medical assistance?

*ANAL AA-FP ENVIRON 2

An Atomic Absorption Experiment for Environmental Chemistry

Stemporzewski, S. E.; Butler, R. A.; Barry, E. P.

J. Chem. Educ. 51,322 (1974)

Lead and zinc in street debris. Straightforward, full directions.

*ANAL APPARATUS CHROMATOG ENVIRON GC INSTR 4

Analysis of an Important Air Pollutant: Peroxyacetyl Nitrate

Stephens, E. R.; Price, M. A.

J. Chem. Educ. 50,351 (1973)

Electron-capture chromatography. Modified Perkin-Elmer 137B IR spectrophotometer, UV source, electron-capture detector (incorporates a beta beta generator).

*ANAL INORG QUAL SOLUB 3

Separation of Arsenic and Copper in Qualitative Analysis

Stock, J. T.

J. Chem. Educ. 35,402 (1958)

Short note on the solubility of copper sulfide precipitate in ammonium polysulfide reagent when arsenic is present.

*ANAL IONSELECT 4

The Response of a Sodium-Ion Selective Electrode in Acid and Alkaline Media

Stock, J. T.

J. Chem. Educ. 47,593 (1970)

Explicit procedure using sodium-ion selective electrode. Hydrogen ion activity calculations.

*ANAL APPARATUS ELECTROCHEM NOPROC 3

Transistorized Power Sources for Constant Current Coulometric Titration

Stock, J. T.

J. Chem. Educ. 46,858 (1969)

Circuit diagrams. Suggestions for many experiments.

*ANAL INORG QUAL 3

The Colorimetric Detection of Arsenic as Copper Arsenide
Stock, J. T.; Garcia, L. M.

J. Chem. Educ. 35 ,401 (1958)

An improvement on the arsine test. Copper arsenide forms as a dark stain when arsine comes into contact with paper wet with a copper solution.

*ANAL AA-FP INSTR MASSPEC 4

Introduction to Signals and Noise in an Instrumental Methods Course

Stolzberg, R. J.

J. Chem. Educ. 60 ,171 (1983)

Atomic absorption measurements are made on Pb solutions using an integrating spectrometer. Mass spectra measurements on ethyl benzoate, using a low resolution or detuned spectrometer plus a microprocessor controlled recorder.

*ANAL ORG PAPERC 3 HAZARD

Diazonium Salts as Spot Test and Synthetic Reagents

Stone, D. B.

J. Chem. Educ. 48 ,413 (1971)

Paper chromatography of various phenols. Visualization by diazotized p-nitroaniline. HAZARD: CHCl₃ (carcinogen) used in developing - use a substitute.

*ANAL ORG COLUMNC NATPROD PAPERC SEPARATION TLC 2 3

Modifications of Solution Chromatography Illustrated With Chloroplast Pigments

Strain, H. H.; Sherma, J.

J. Chem. Educ. 46 ,476 (1969)

The definitive description of the refined techniques needed for good results in extraction and chromatography of plant pigments.

*ANAL CHROMATOG COLUMNC HISTORIC 2 3

M. Twsett: "Absorption Analysis and Chromatographic Methods: Application to the Chemistry of the Chlorophylls"

Strain, H. H.; Sherma, J.

J. Chem. Educ. 44 ,238 (1967)

Historic experiment. CaCO₃ column, green leaves.

*ANAL QUAL TECHNIQUE 2

Improving the Potassium Flame Test

Strong, F. C., III

J. Chem. Educ. 46 ,178 (1969)

Simple modifications.

*ANAL ACBA KEQ TITN 3

Is a Weak Acid Monoprotic?: A new look at titration curves

Sturrock, P. E.

J. Chem. Educ. 45 ,258 (1968)

Weak acid titration, with criterion ΔpH (change from 1/4 to 3/4 equivalence) greater than 1.0 for dibasic acid.

*ANAL COLUMNC CONSUMERPROD DISTRIB GC PESTICIDE TLC 4

An analytical procedure for the determination of pesticides in food.

Subach, D. J.; Bell, M. E. B.

J. Chem. Educ. 50 ,855 (1973)

Analysis for Chlordane, Endrin, Heptachlor, etc. in vegetable produce. 3-4 lab periods. Florisil column. CAUTION: pesticides - extr. toxic.

*ANAL ENVIRON NOPROC 2

Air Pollution Measurements in the Freshman Laboratory

Suplinkas, R. J.

J. Chem. Educ. 49 ,24 (1972)

To accompany a non-majors "chemistry and environment" course. Commercial portable gas train.

*ANAL ORG TLC 3 HAZARD

A Spray Technique for the Preparation of TLC Plates

Swaim, P. D.; Loyola, V. M.; Harlan, H. D.; Carlo, M. J.

J. Chem. Educ. 51 ,331 (1974)

Silica gel slurry sprayed on with Sears-Roebuck paint sprayer. R_f values given for caffeine, etc. HAZARD: benzene (carcinogen), is avoidable.

*ANAL ORG PREP PROJ QUAL SAFETY 1 2

Non-Cyanide Detection of Cadmium(II) and Copper(II) Ions in a Mixture

Symal, A.; Ahmad, S.

J. Chem. Educ. 60 ,518 (1983)

Short note reports a ligand, 3-(o-carboxyphenyl)-1-methyltriazine-1-oxide, which precipitates Cu+2 quantitatively at pH 1.0-7.5 as a green complex. Cd+2 is then identified by NaOH pptn. Preparation of the ligand from methyl-hydroxylammonium chloride, and anthranilic acid is given by ref.

*ANAL ELECTROCHEM KSP 2 3

Potentiometric Determination of Solubility Product Constants:

A laboratory experiment

Tackett, S. L.

J. Chem. Educ. 46, 857 (1969)

Silver and calomel electrodes and standard Ag^+ , Br^- , I^- , and Cl^- solutions required. Modification used at Stony Brook; works well.

*ANAL ELECTROANAL NOPROC STATISTICS TITN 4

Comparison of Endpoint Methods: A coulometric titration experiment.

Tackett, S. L.

J. Chem. Educ. 49, 52 (1972)

Oxidation of arsenite by electrolytically generated iodine, comparing three endpoint methods: (1) starch, (2) potentiometric, (3) amperometric. Statistics used in calibration of 1-ml pipets.

*ANAL APPARATUS HANDICAPPED PH TITN 2

A pH Titration Apparatus for the Blind Student

Tallman, D. E.

J. Chem. Educ. 55, 605 (1978)

Construction of the apparatus given.

*ANAL ORG DEMO GC PROJ 1 2

Simple Classroom Demonstration of Gas Chromatography

Taylor, M. A.; Kolb, K. E.; Bricker, C. E.

J. Chem. Educ. 58, 41 (1981)

The basics of gc (without the quantitative feature) demonstrated using natural gas as carrier gas, a glass tube filled with detergent as column, and a hot Cu wire as detector of halogen-containing compounds. Possible project.

*ANAL AA-FP APPARATUS 5 HAZARD

Determination of Mercury by a Simple Atomic Absorption Method

Thistlethwaite, P. J.; Trease, M.

J. Chem. Educ. 51, 687 (1974)

Use of "ultraviolet shadow" of mercury to analyze for trace Hg in aq. sol'ns. Apparatus design shown. Has not been used as a lab exercise. See also Arganer, P.J.; White, C.E., J. Chem. Educ. 49, 27 (1972).

Hazard: mercury vapor.

*ANAL ORG IONX PAPER 3 HAZARD

Ion Exchange Paper Chromatography

Thomas, A. T.; Phillips, J. P.

J. Chem. Educ. 38, 406 (1961)

Arginine, tyrosine, leucine and aspartic acid separated on a cation-exchange impregnated paper, and on Whatman #4 filter paper. A ninhydrin dip was used for visualization. HAZARD: ninhydrin is a carcinogen.

*ANAL PREP UVIS 4

The Preparation of Barium Chloranilate

Thomas, E. B.

J. Chem. Educ. 36, 383 (1959)

Preparation of a reagent for the colorimetric det'n of sulfate from chloroanilic acid and barium hydroxide. Straightforward.

*ANAL NOPROC QUAL 2

Abridged Qualitative Analysis with Limited Reagents

Thompson, M. L.; Bixler, J. W.

J. Chem. Educ. 48, 113 (1971)

Four cations (from a limited list) are identified using only HCl , H_2SO_4 , NaOH , NH_3 by procedures which students must develop using refs.

*ANAL ORG ACBA TITN 4

Determination of Saponification Equivalents of Phenolic Esters

Tobey, S. W.; McGregor, S. D.; Cottrill, S. L.

J. Chem. Educ. 38, 611 (1961)

Modification of an old procedure gives good results with phenolic esters.

*ANAL APPARATUS FORENSIC NOPROC REDOX 2

Determination of Alcohol in Breath for Law Enforcement

Treptow, R. S.

J. Chem. Educ. 51, 651 (1974)

Dichromate-photometric breath analyzer.

*ANAL AA-FP ENVIRON 2

Roadside Salt Pollution and the Absorption-Emission Spectra of Sodium: a General Chemistry Experiment

Tripp, T. B.; Nadeau, J. L.

J. Chem. Educ. 51, 130 (1974)

Analysis of soil samples and rock salt.

***ANAL ORG APPARATUS GC INSTR 3**

An Undergraduate Experiment in Gas Chromatography and C,H-Microanalysis
Tse, R. S.
J. Chem. Educ. 48 ,550 (1971)
Construction of apparatus for carbon (as CO₂) and hydrogen (as H₂O) in samples by combustion in a copper-copper oxide packed tube furnace followed by gc (thermal conductivity).

***ANAL ORG QUAL 3 HAZARD**

A Test for the Subclasses of Aliphatic Amines
Valentine, J. L.; Enriken, J. B.; Hanson, M. W.
J. Chem. Educ. 41 ,569 (1964)
Describes use of 3,3',5,5'-tetrabromophenolphthalein ethyl ester (bromophthalein magenta E) as a qualitative reagent. HAZARD: CCl₄

***ANAL ORG CONSUMERPROD DISTRIB UVIS 3**

Ultraviolet Spectrophotometric Determination of Caffeine in Cola Drinks.
VanAtta, R. E.
J. Chem. Educ. 56 ,666 (1979)
Caffeine is extracted from cola with dichloromethane. Standard caffeine solution needed. Within capacity of most second-semester freshman.

***ANAL GC QUANT 3**

Gas Chromatographic Determination of Methyl Salicylate in Rubbing Alcohol:
An experiment employing standard addition.
VanAtta, R. E. E.; VanAtta, R. L. L.
J. Chem. Educ. 57 ,230 (1980)
An accurate measure of methyl salicylate obtained using known added amounts of the ester. Simple equipment.

***ANAL ELECTROANAL INSTR PHARM 4**

Cyclic Voltammetry Experiment
VanBenschoten, J. J.; Lewis, J. Y.; Heineman, W. R.; Roston, D. A.
Kissinger, P. T.
J. Chem. Educ. 60 ,772 (1983)
A multi-period experiment, using standard equipment. Part 1 studies the ferri-ferrocyanide system. Part 2 investigates the more complex electrochemical behavior of acetaminophen. Part 3 involves student exploration of variable factors.

***ANAL ACBA APPARATUS ELECTROCHEM INSTR 4**

Precise Coulometric Titrations Based on Silver Coulometer Measurements
VanLente, K. A.; VanAtta, R. E.; Willard, H. H.
J. Chem. Educ. 36 ,576 (1959)
Research report. A new type of silver coulometer and a simpler apparatus suitable for a laboratory experiment is described. No procedure.

***ANAL QUAL 2**

A Spot Test Scheme for the Identification of Metal Ions
Vavoulis, A.
J. Chem. Educ. 39 ,395 (1962)
Spot tests (no new ones) incorporated into a qual. scheme.

***ANAL INORG IONX QUAL 2 HAZARD**

Ion Exchange Separation of Cadmium
Vick, M. M.; Harris, L. H.
J. Chem. Educ. 38 ,414 (1961)
An 'in situ' ion exchange method which may be applicable to other species. Dowex-1. HAZARD: Cd++ is a serious liver-kidney poison.

***ANAL INORG QUAL 2 HAZARD**

A Non-Cyanide Separation of Copper from Cadmium
Waggoner, W. H.
J. Chem. Educ. 37 ,411 (1960)
Thiocyanate ion will precipitate Cd++ from acid solution, but will not ppt Cu++. HAZARD: avoid Cd++.

***ANAL INSTR NMR QUANT 3 4**

Quantitative Analysis of a Mixture by NMR Spectroscopy
Wallace, T.
J. Chem. Educ. 61 ,1074(1984)
Note gives simple instructions for student lab with mixtures of 1,2,4,5-tetramethylbenzene and fluorene, with dibromomethane as internal standard.

***ANAL INORG ORG PAPER QUAL 2**

Experiments in Inorganic Paper Chromatography
Walton, H. F.
J. Chem. Educ. 42 ,477 (1965)
Sensitive spot tests allow det'n of uranium, copper, cobalt, nickel. Easy.

*ANAL PHYS ELECTROANAL 4

Sensitive Electroanalysis Using Solid Electrodes

Wang, J.

J. Chem. Educ. 59,691 (1982)

Hydrodynamic modulation voltammetry, simple "stopped-stirring" and "stopped-flow" techniques are extensions of mercury electrode polarography.

Determination of (e.g.) ascorbic acid in Vitamin C tablets. Article describes and gives references to the measuring technique. Little experimental detail.

*ANAL ELECTROANAL ENVIRON INSTR WATERCHEM 4

Anodic Stripping Voltammetry; An Instrumental Analysis Experiment

Wang, J.

J. Chem. Educ. 60,1074(1983)

Standard polarographic analyzer with a home-made stationary carbon disk electrode (also commercially available) plated with a mercury film is used for trace metal analysis. After standardizing with 0.17 micromolar Pb, natural waters are analyzed for copper, lead and cadmium.

*ANAL INORG QUAL 3

The Inclusion of Tungsten and Thallium in the Elementary Scheme of Qualitative Analysis

Waters, K. L.; Brockman, C. J.; Waggoner, W. H.

J. Chem. Educ. 34,137 (1957)

Explicit. Intended to enrich a classical qual. course. Tl(I) and W(VI) ppt with the Group I cations. Tl(I) follows Pb(II) through the classical scheme; W(VI) follows Ag(I). Tl(I) is separated as the chromate and d'td as the iodide. W(IV) is separated as the heteropoly phosphate and d'td as tungstic acid-Basic Brown complex.

*ANAL QUAL 2

The Identification of an Unknown Alloy: A first experiment in elementary chemistry

Watson, N. V.

J. Chem. Educ. 48,324 (1971)

Note reports successful use of a "guided tour" experiment to analyze Mg-Al alloys using physical properties, acid solubility, and a limited number of reagents as a first experiment.

*ANAL COMPLEXIM CONSUMERPROD EDTA 2

A Simple Titrimetric Determination of Lead in Gasoline

Watt, S. L.; Martino, T. M.; Chamberlain, M. A.; Laswick, P. H.

J. Chem. Educ. 54,262 (1977)

One period, straightforward.

*ANAL INSTR UVIS 3

Dependence of the Beer-Lambert Absorption Law on Monochromatic Radiation:

An experiment in spectrophotometry

Wentworth, W. E.

J. Chem. Educ. 43,262 (1966)

Pr(+3) spectrum 420-620 nm has 4 absorptions of various 1/2 band widths.

Absorption measurements (Beckman DU) depend on whether a wide peak or a sharp peak is measured.

*ANAL APPARATUS ENVIRON QUAL TECHNIQUE 2 3

Air Pollution Studies: The ring oven technique

West, P. W.; Sachdev, S. L.

J. Chem. Educ. 46,96 (1969)

Easily prepared apparatus used to obtain and analyze particulates.

*ANAL INORG QUAL REVIEW 3

Qualitative Analysis and Analytical Chemical Separations Without the Use of Sulfides

West, P. W.; Vick, M. M.

J. Chem. Educ. 34,393 (1957)

Complete flow-charts, minimal procedures. Non-sulfide separations are discussed. Groups are 1) chloride group, 2) basic benzoate, 3) fluoride, 4) hydroxide. 18 references.

*ANAL INORG PREP TITN 4 HAZARD

Total Analysis of Tin Tetraiodide: A multipurpose experiment

Wheatland, D. A.

J. Chem. Educ. 50,854 (1973)

Prepn. by direct combination of elements (ref.). Comparison of four titrimetric methods for chloride and four for tin. No procedure for titrations. HAZARD: chloroform, carcinogen

*ANAL ACBA ELECTROANAL 3

Tris(hydroxymethyl)aminomethane as a Titrimetric Standard

Whitehead, T. H.

J. Chem. Educ. 36,297 (1959)

Reagent named in title is now available in pure form (Certified Reagent T-395). Potentiometric titration shows this reagent has only one stoichiometric point at pH 4-5.

*ANAL QUAL 2 HAZARD

The Separation and Identification of Cadmium and Copper Ions
Whitehead, T. H.; Hatcher, G. K.
J. Chem. Educ. 39,399 (1962)
A shorter procedure, avoiding cyanide, is the differential reduction
Cu(II) to Cu(I), and precipitation as cuprous acetylide. This is reported
to be shock sensitive when dry, but authors of article find the precipitate
is stable. Avoid cadmium, acetylides.

*ANAL INORG ORG PHYS INTEGR NOPROC RADIOCHEM 2

A New Freshman Chemistry Laboratory Program
Wiberley, S. E.; Richtol, H. H.
J. Chem. Educ. 41,146 (1964)
Description of lab program, heavily oriented towards instrumentation.
Includes gc, ir, prep, sol'n equilib., phase equilib.,etc.

*ANAL INSTR PHOTO TECHNIQUE 3

An Experiment in Flame Photometry
Willard, H. H.; Lente, K. A.; VanAtta, R. E.
J. Chem. Educ. 34,192 (1957)
Beckman B with flame attachment. Representative unknowns. Trace analysis:
Na(I), K(I), Ba(II), etc. Wave-lengths of measurement given.

*ANAL ORG KEQ NONAQ PROJ 3

The Analysis of an Amine Mixture: An Introductory Analysis Experiment
Williams, T. R.
J. Chem. Educ. 59,202 (1982)
Mixture of two amines for which acidity constant determination requires
non-aq. titration. Separation and identification by various means. Three
or four periods.

*ANAL INORG QUAL 3 HAZARD

A Specific Qualitative Reagent for Copper
Williams, T. R.; Burton, F.
J. Chem. Educ. 38,413 (1961)
T-sulfonamididine precipitates copper quantitatively over a wide pH range.
Cd++ does not interfere. HAZARD: procedure was devised before Cd++,
thioacetamide were known to be dangerous.

*ANAL MICELLE QUAL 2

The Use of Polyelectrolytes to Improve Qualitative Analysis Preparations
Williams, T. R.; Carter, R.
J. Chem. Educ. 41,442 (1964)
Modification of conventional qual. procedures incorporates flocculating
agents - makes separations cleaner, easier.

*ANAL INORG COORD UVIS 2

An Experiment in the Characterization of Coordination Compounds
Williams, T. R.; Haynes, L. W.
J. Chem. Educ. 54,246 (1977)
An unknown cobalt coordination compound is given; various methods for
identification are used, including UV-VIS spectrum.

*ANAL INORG APPARATUS QUAL 2

A Gas Testing Device Using Liquids or Test Papers
Williams, T. R.; Stock, J. T.
J. Chem. Educ. 36,384 (1959)
Diagram is given for an inexpensive "gas testing device" for qual.
analysis.

*ANAL NOPROC REDOX STOICH TITN UVIS 2

A New Oxidation-Reduction Experiment
Williams, T. R.; Vandoren, J. D.
J. Chem. Educ. 51,421 (1974)
Reduction of Ce(IV) by iodide. Calibration curve prepared and absorbance at
375 nm used to measure Ce(IV) before and after addition of measured aliquot
of std. reductant. Stoichiometry of redox reaction then determined.

*ANAL PHYS IR TECHNIQUE 4

Integrated Infrared Band Intensities: A physical chemistry experiment
Wilson, H. W.
J. Chem. Educ. 51,392 (1974)
CHCl₃ at 1216 cm⁻¹. Comparison of different mathematical methods for
estimating area under the band.

*ANAL CHROMATOG CONSUMERPROD DEMO NATPROD 1 HAZARD

Chromatography on Chalk
Wollrab, A.
J. Chem. Educ. 52,809 (1975)
Easy demo using felt-tip markers, inks, extracts of flower petals, etc.,
and ordinary chalk. HAZARD (avoidable): benzene, carbon tet.

***ANAL GRAVIM SEMIQUANT STOICH 2 HAZARD**

Determination of the Equivalent Weight of Metals: A freshman research project

Wolthuis, E.; DeVries, D.; Poutsma, M.

J. Chem. Educ. 34 ,133 (1957)

A weighed amount of Zn, Cd or Mn metal is dissolved in a weighed Erlenmeyer flask containing 6M HCl and the resulting solution evaporated to dryness.

The flask + residue (assumed to be the anhydrous chloride) is then weighed.

Analysis of sources of error is given; student analyses show an average error of approx. 0.25%. HAZARD: avoid cadmium.

***ANAL QUAL 1 2**

Qualitative Identification of Potassium Ions Using Didymium Glasses

Wood, W. F.

J. Chem. Educ. 61 ,1024(1984)

Didymium glasses used by glassblowers are much superior to cobalt glass for identifying K in the presence of Na.

***ANAL REDOX TITN 2 3**

Hydrogen Peroxide in Cleansing Antiseptics

Worley, J. D.

J. Chem. Educ. 60 ,678 (1983)

A gas collection system described in an earlier JChemEd ref. is used to measure O₂ from the reaction of peroxide with 0.01M permanganate. Can be used with aqueous peroxides, which can be checked by titn using std. permanganate. CAUTION is noted concerning peroxides with strong oxidizing agents.

***ANAL AA-FP BIOCHEM INSTR MISTAKE 2 3**

Molecular Weights of Hemoglobin and Myoglobin by Atomic Weight Absorption Spectrophotometry

Worley, J. D.; Londo, T.

J. Chem. Educ. 60 ,650 (1983)

Brief description of a 1-lab period expt. Solutions of the two iron-containing proteins are prepared by dissolution in aq. HCl and dilution for AA-analysis for iron. Standards are prepared by dissolving iron wire in aq. HCl. MISTAKE: the 'weight' in the title must be an error.

***ANAL ACBA COMPUTER KEQ TITN 2**

Automatic Titrimetry in Introductory College Chemistry

Zajicek, O. T.

J. Chem. Educ. 41 ,554 (1964)

Titration of unknown mixture of a strong and a weak acid. Optional data reduction by computer. Requires a constant rate buret and a recording pH meter.

***BIOCHEM ENZYME NATPROD PAPER 2 HAZARD**

Demonstration of Transketolase Activity in Plant Leaves. Synthesis of L-Glucoheptulose.

Abernethy, J. L.

J. Chem. Educ. 42, 286 (1965)

Mature plant leaves take L-arabinose from solution and enzymatically form L-glucoheptulose. Identified by paper chromatography. Color developed by orcinol in trichloroacetic acid. HAZARD: trichloroacetic acid gives serious skin burns.

***BIOCHEM ORG CHIRAL ENZYME 3 HAZARD**

Papain as an Enzyme Catalyst in Undergraduate Organic Chemistry

Abernethy, J. L.; Kientz, M.

J. Chem. Educ. 36, 582 (1959)

Synthesis with aromatic amines or hydrazides and amino acids (hippuric, carbobenzoxy-D,L-alanine). Enzyme activated with H₂S. Stored under refrigeration for long life. May include resolution of D,L-alanine, synthesis of substrates. Crude incubator. HAZARD: H₂S - nerve toxin.

***BIOCHEM ORG CATAL ENZYME NATPROD PREP RESOLUTION 3**

Ficin as a Catalyst in Organic Syntheses

Abernethy, J. L.; Leonardo, G. L.

J. Chem. Educ. 41, 53 (1964)

Ficin, an enzyme derived from fig trees, and commercially available, catalyzes amide synthesis. Experiments include reaction of acylated amino acids (hippuric acid or carbobenzoxyalanine) with aminophenols. Synthesis of optically active amides in good yield if DL amino acids are used. Extensions suggested.

***BIOCHEM ENZYME KIN UVIS 3**

Acid Phosphatase Characterization: An undergraduate biochemistry laboratory experiment

Adams, G. S.; Towers, C. V.

J. Chem. Educ. 54, 780 (1977)

Enzyme isolation as crude homogenate from beef liver, heart, or aorta.

Assay by spectrophotometer (p-nitrophenol standard) at 410 nm. Extensions to investigate substrate specificity, inhibition, effect of metal ions, SH groups.

***BIOCHEM NUCL.ACID POLARIM 3**

Optical Rotation and the DNA Helix-to-Coil Transition: An undergraduate project

Baker, G. L.; Alden, M. E.

J. Chem. Educ. 51, 591 (1974)

Optical rotation of DNA (purchased) solution measured with (filtered) yellow-green light at 30-100 deg. in apparatus constructed in labs.

***BIOCHEM PHYS ELECTROPHOR KIN VITAMIN 3**

Paper Electrophoretic Study of Rates of Consecutive Reactions:

The Deamidation of Vitamin B-12

Barlow, G. H.

J. Chem. Educ. 38, 37 (1961)

Hydrolysis with hydrochloric acid. Samples taken at various times and examined by paper electrophoresis.

***BIOCHEM AFFC PREP UVIS 4**

Separation of Albumin, Ceruloplasmin and Transferrin from Human Plasma

Barnes, G.; Frieden, E.

J. Chem. Educ. 59, 873 (1982)

Blood plasma separated by column chromatog. with Affi-Gel Blue and with DEAE-Sephadex by gradient elution. Spectral properties (and oxidase activity of ceruloplasmin) measured. Two periods.

***BIOCHEM ORG PH PREP TITN 3**

A Study on Amino Acids: Synthesis of α -Aminophenylacetic Acid (Phenylglycine) and Determination of its Isoelectric Point

Barrelle, M.; Gaude, D.; Salon, M. C.

J. Chem. Educ. 60, 676 (1983)

Phenylglycine is prepared from phenylacetic acid by NBS bromination followed by rxn w. aq. NH₃; product is purified by recryst. at the isoelectric point. The isoelectric point is detd from pH data collected for phenylacetic acid and benzylamine in a separate expt; may also be obtained by titration of the product.

***BIOCHEM INORG KIN PORPHYRIN PREP PROJ 4 5**

An Advanced Laboratory Experiment in Bioorganic Chemistry

Beckmann, B. A.; Buchman, A.; Pasternack, R. F.; Reinprecht, J. T.

J. Chem. Educ. 53, 387 (1976)

Preparation of m- and p-phenyl substituted derivatives of alpha, beta, gamma and delta-tetraphenylporphine from pyrrole (lit. ref. given) zinc derivatives and UV. Data for 12 compounds given. Kinetics of metal ion insertion into tetrakis(4-N-methylpyridyl)porphine (prepared from tetrakis(4-pyridyl)porphine (synthesized or purchased).

***BIOCHEM KIN VISC 3**

The Biochemistry of the Muscle Contraction Process: An Undergraduate Laboratory Experiment Using Viscosity to Follow the Progress of a Reaction
Belliveau, J. F.; O'Leary, G. P.; Hajian, H.

J. Chem. Educ. 58,442 (1981)

Detailed presentation. Short easy procedure using common laboratory equipment. The effect of the addition of buffered ATP solutions on the viscosity of rabbit muscle actomyosin solutions is studied as a function of time.

***BIOCHEM PHYS ENZYME KIN UVIS 4**

Alpha-Chymotrypsin: Enzyme concentration and kinetics

Bender, M. L.; Kezdy, F. J.; Wedler, F. C.

J. Chem. Educ. 44,84 (1967)

Hydrolysis of 4-nitrophenyl trimethylacetate catalyzed by alpha-chymotrypsin in thermostatted cell followed by visible spectroscopy.

***BIOCHEM PHYS PH VISC 3**

Viscometric Determination of the Isoelectric Point of a Protein

Benson, J. E.

J. Chem. Educ. 40,468 (1963)

Viscosity of gelatin solutions measured (Ostwald viscometer) as a function of pH.

***BIOCHEM PHYS KIN MEMBRANE UVIS 3 4**

Kinetics of Solute Permeability in Phospholipid Vesicles

Bittman, R.; Blau, L.

J. Chem. Educ. 53,259 (1976)

Liposomes prepared (not by students?) from phosphatidylcholines, some with added cholesterol. Assay of non-electrolyte (eg glycol, thiourea) permeability and of water permeability by absorbance at 600 nm. Can be combined with series of expts. on egg-yolk lipids published earlier.

***BIOCHEM ENZYME 2 3**

A Laboratory Demonstration of Blood Catalase

Blackwell, R. Q.; Fosdick, L. S.

J. Chem. Educ. 32,588 (1955)

Catalase in blood measured by temperature rise in the decomposition of a standard hydrogen peroxide solution. Simple apparatus.

***BIOCHEM IONX PAPERC RADIOCHEM TRACER UVIS 4**

The Incorporation of Glucose into Chelidonic Acid: An experiment in plant biochemistry

Bohm, B. A.

J. Chem. Educ. 43,539 (1966)

Incorporation of a precursor into a naturally-occurring molecule. C-14 labelled glucose is fed to a lily-of-the-valley plants. After metabolism, plant tissue is extracted with boiling ethanol. Presence of chelidonic acid (I) establ. by paper chromatog.; site of C-14 atoms in (I) est. by cleavage of (I) with aq. Br₂. Much manipulation.

***BIOCHEM ANAL PAPERC 4**

Descending Paper Chromatography of Oligosaccharides: A Biochemistry Laboratory Experiment

Borders, C. L., Jr.

J. Chem. Educ. 49,437 (1972)

Commercial chamber. Moving phase: ethyl acetate-pyridine-water.

Visualization by alkaline silver oxide spray. R_f (glucose) values for 12 di- and tri-saccharides.

***BIOCHEM TECHNIQUE UVIS 4**

A Sedimentation Experiment Using a Preparative Ultracentrifuge

Boudreau, R. E.; Heaney, A.; Weller, D. L.

J. Chem. Educ. 52,128 (1975)

Devised for molecular biology course. Illustrates use of ultracentrifuge in isolating and purifying bacterial ribosomes, determining sedimentation coefficients and subunit structure of 70-S ribosome, and role of magnesium ion in associating of subunits.

***BIOCHEM ANAL ENZYME KIN UVIS 3**

A Spectrometric Assay of Polyphenoloxidase Activity: A Special Project in Enzyme Characterization.

Boyer, R. F.

J. Chem. Educ. 54,585 (1977)

Polyphenoloxidase (tyrosinase) is extracted from food (potatoes) with a phosphate buffer. Kinetics of hydroxylation of dihydroxyphenylalanine measured by recording spectrophotometer at 475 nm (or spec 20).

Inhibition studies are suggested.

***BIOCHEM AFFC UVIS 4 HAZARD**

The Separation of Chymotrypsin and Chymotrypsinogen:

An Affinity Chromatography Experiment for Biological Chemistry Students

Branchini, B.; Ziolkowski, R.

J. Chem. Educ. 56,281 (1979)

D-Tryptophan methyl ester was bound to CH-Sepharose 4-B by use of EDC, (1-ethyl-3-dimethylaminopropyl)carbodiimide, (HAZARD), using wrist shaker. Chymotrypsin and chymotrypsinogen separated by this column were assayed by hydrolysis of glutaryl-L-phenylalanine para-nitroanilide.

***BIOCHEM ANAL ELECTROANAL PROJ 4**

A Simple Method for the Determination of Hemoglobin-Oxygen Dissociation Curves

Brittain, T.

J. Chem. Educ. 59,253 (1982)

Polarography, using Clark oxygen electrode system measures O₂ conc.; submitochondrial particles from beef-heart to absorb oxygen. Effect of temp., pH. Good project.

***BIOCHEM ORG TLC 3 HAZARD**

Peptide Hydrolysis and Amino Acid Hydrolysis: A first year organic or biochemistry experiment

Buchanan, D. N.; Kleinman, R. W.

J. Chem. Educ. 53,255 (1976)

HCl hydrolysis of glycyl-L-leucyl-L-tyrosine in sealed tube at 110 deg., developed in two different solvents. HAZARD: sealed tubes; internal pressure.

***BIOCHEM ENZYME KIN UVIS 4**

Biochemistry: Cholinesterase Kinetics

Carper, M. A.; Carper, R. W.

J. Chem. Educ. 50,599 (1973)

Butyrylthiocholine iodide and acetylthiocholine iodide as substrates for horse serum butyryl cholinesterase. Kinetics measured by thiocholine color reaction with 5,5-dithio-bis-alpha-nitrobenzoate at 412 nm. Lineweaver-Burke plots interpreted to give pK's for Es complex, free enzyme, free substrate.

***BIOCHEM COMPLEX ENZYME FLUOR POLARIM 5**

Biochemistry Laboratory Experiment: Polarized Fluorescence

Carper, M. A.; Carper, W. R.

J. Chem. Educ. 45,662 (1968)

Detection of ternary complexes of enzyme (bovine glucose dehydrogenase), dpn, and glucose and of inhibitor (pyridoxamine) by change in fluorescence (spectrofluorometer) and polarization (attached prisms).

***BIOCHEM ORG DISTRIB NATPROD PREP SEPARATION TLC 4**

Pigments From Some Marine Specimens: The isolation and spectral characterization of spinochromes

Chang, C. W. J.; Moore, J. C.

J. Chem. Educ. 48,408 (1971)

Colored pigments in spines of sea urchins (gathered or purchased) isolated by acid dissolution and extraction of lipids. Separation on silica gel with plates deactivated by HCl.

***BIOCHEM ORG BACTERIA DEMO NATPROD 3**

The Chemistry of Winemaking: An unique lecture demonstration

Church, L. B.

J. Chem. Educ. 49,174 (1972)

A year-long demo starting from grapes. Could be individual or group experiment. Wine chemistry illustrates many complex reactions. Complete procedure including when to file Form 1541 with the IRS.

***BIOCHEM DEMO 1**

Molecular Iodine from Gorgonians: A laboratory experiment in marine biochemistry

Cierszko, L. S.; Chang, C. W. J.

J. Chem. Educ. 55,744 (1978)

A simple demonstration, not an experiment despite the title. Exoskeletons heated with conc. sulfuric acid give violet vapors.

***BIOCHEM ANAL PAPERC 3 HAZARD**

Identification of Amino Acids in a Protein Hydrolysate by Paper Chromatography

Clapp, L. B.; Hansch, C.

J. Chem. Educ. 37,293 (1960)

Amino acid standards. Ninhydrin. Rf values for 16 amino acids.

HAZARDS: Sulfuric acid and barium hydroxide reaction is exothermic and not identified as hazardous in article. Ninhydrin is a suspected carcinogen.

***BIOCHEM ORG CHIRAL ENZYME PREP RESOLUTION 4**

Enzymatic Resolution: An organic-biochemical laboratory experiment

Clement, G. E.; Potter, R.

J. Chem. Educ. 48,695 (1971)

Alpha-chymotrypsin used to resolve DL-phenylalanine. Detailed experimental directions. Useful for isolation of D-amino acids.

***BIOCHEM ANAL APPARATUS GC NATPROD 4**

Gas Chromatographic Determination of Glutethimide in Biological Fluids:
An Analytical Chemistry Experiment

Cohen, J. L.; Koda, R. T.

J. Chem. Educ. 51,133 (1974)

GC with flame ionization detector, glass column, centrifuge; aliquot mixer;
p-dimethylaminobenzaldehyde; blood; urine. Glutethimide is a
sedative-hypnotic drug. CAUTION: Blood is an infection hazard.

***BIOCHEM PHYS ENZYME IONSELECT KIN 4**

Enzyme Activity and Inactivation

A Laboratory Experiment

Cowans, J. A.; Katz, S. A.

J. Chem. Educ. 42,553 (1965)

Ammonium ion selective electrode measures ammonia from urea hydrolysis by
urease; inhibition by copper(II). pH meter and recorder.

***BIOCHEM ANAL ORG PAPER C 3 HAZARD**

Chromatographic Separation and Identification of Amino Acids

Cunningham, B. A.

J. Chem. Educ. 48,275 (1971)

First-direction solvent: 1-butanol-MEK-H₂O. Second: 1-butanol-HOAc-H₂O.
Each requires 5 hours for 20 cm sheet. Color developing reagents:
ethanolic cyclohexylamine, ninhydrin. Hazard: Ninhydrin is a suspected
carcinogen.

***BIOCHEM ANAL UVIS 3 HAZARD**

Spectrophotometric Method for Determination of Glucose in Blood Serum: A
freshman lab. experiment for medically and biologically oriented students

Daines, T. L.; Morse, K. W.

J. Chem. Educ. 53,126 (1976)

Blood serum of various concentrations of glucose treated with o-toluidine,
form blue-green complex, analysis at 635 nm. HAZARD: o-toluidine is
possible carcinogen.

***BIOCHEM ANAL ENZYME PAPER C QUAL 2**

Demonstrating Enzymatic Hydrolysis of Glucosides by Paper Chromatography

Darling, S. F.

J. Chem. Educ. 38,503 (1961)

Simple beta-glucosides are hydrolyzed by beta-glucosidase; the reaction is
followed with paper chromatography. Developing solution BuOH/pyridine/water
or EtOAc/HOAc/water. Visualization is w. silver nitrate spray.

***BIOCHEM ORG ENZYME INTEGR PH UVIS 3**

Preparation of Immobilized Enzymes, and Determination of their pH Activity
Profile. An Integrated Organic-Biology Experiment.

Dejong, P. J.; Kumler, P. L.

J. Chem. Educ. 51,200 (1974)

Activated glass beads treated para-nitrobenzoyl chloride, reduced sodium
dithionite, diazotized. Phosphate-buffered trypsin is coupled, and
immobilized enzyme used to hydrolyze casein at varying pH.
Analysis by folin reagent in spec-20 at 660 nm.

***BIOCHEM ANAL DISTRIB GC PAPER C TLC 4**

Analysis of Egg Lipids: A student project

DeKoning, A. J.

J. Chem. Educ. 51,48 (1974)

Lipids from egg yolk by chloroform extraction separated by solubility into
phospholipids and non-phosphorylated. Phosphorus analysis by phosphomolybdic
acid and molybdenum blue, choline ethanolamine, serine and inositol by paper
chromatography. Phospholipids separated by tlc and phospholipids as methyl
esters by gc.

***BIOCHEM ENZYME PAPER C 2 3**

Allied Health Chemistry Laboratory: Amino acids, insulin, proteins, and
skin

Dever, D. F.

J. Chem. Educ. 52,338 (1975)

Much detail on pre-lab, model building, student involvement. Complete
experiment given. Paper chromatography of amino acids from skin extract,
insulin, etc., developed with acetonitrile/ammonium acetate mixture.
Visualization by ninhydrin.

***BIOCHEM ACBA ENZYME KIN PH 3**

The Enzyme Kinetics of Phospholipase A: A student experiment

DeVine, J. E.; Toom, P. M.

J. Chem. Educ. 52,816 (1975)

Lyophilized snake venom hydrolysis of lecithin followed by pH change.
Kinetics used to find K_m and V_{max}. Additionally, effect of metal ions,
denaturation temperature can be studied.

***BIOCHEM COLUMN GC TECHNIQUE TLC 3 HAZARD**

Isolation and Characterization of Phosphatidyl Choline from Spinach Leaves

Devor, K. A.

J. Chem. Educ. 56,758 (1979)

Straightforward. Designed to teach lab technique used in lipid biochemistry. Three 3-hr periods. Fatty acid esters by GC, phosphatidyl choline by silica gel TLC, extraction and chromatography uses chloroform.

HAZARD: Chloroform: carcinogen, substitute.

***BIOCHEM ANAL GELC UVIS 4 HAZARD**

Student Experiments on the Gel Filtration of Proteins

Dewhurst, F.

J. Chem. Educ. 46,864 (1969)

Hemoglobin (prepared from blood; Caution: infection hazard) and serum solutions mixed, hemoglobin-haptoglobin complex separated on Sephadex, measured by absorption at 415 nm. Also albumin with adsorbed bromphenol blue separated from serum, measured at 605 nm. HAZARD: chloroform is a carcinogen.

***BIOCHEM INORG PORPHYRIN PREP REVIEW 4**

Metal-replaced Hemoproteins. A Review with Introductory Laboratory Preparation of Cobalt Myoglobin

Dickinson, L. C.

J. Chem. Educ. 53,381 (1976)

Extensive discussion. Includes procedure for prep. of a cobalt protoporphyrin from human and sperm whale myoglobin. Demonstrates visible spectral changes, oxygen reversibility and oxidation.

***BIOCHEM APPARATUS BACTERIA PREP 4**

Preparation of the Proteins by Micro-Organisms: A laboratory experiment

Dieteren, H. M. L.; Schouteten, A. P. H.

J. Chem. Educ. 47,663 (1970)

Simple reactor described. Yeast grown in nutrient mix containing normal alkanes at 30 deg., pH of 4.

***BIOCHEM ENZYME RADIOCHEM 4**

The Degradation of C-14-Glutamic Acid by L-Glutamic Acid Decarboxylase: An Undergrad Biochem Exp't Utilizing a Simple Semi-micro Carbon Dioxide Trap

Dougherty, C. M.; Dayan, J.

J. Chem. Educ. 59,74 (1982)

Decarboxylation of title product followed by trapping evolved CO₂ in a basic solution; scintillation counter. Semi-micro procedure. Unknowns glutamic acid mixtures with various specific labelling.

***BIOCHEM DEMO PROJ UVIS 4**

A Model Antigen-Antibody System for Classroom Use

Doyle, R. J.; Cronholm, L.

J. Chem. Educ. 46,868 (1969)

Concanavalin A from jack pine seeds as antibody, various polysaccharides as antigens. A series of demonstrations (OK for student exp't) given in outline form - more, and extensions, by references. Measurements by turbidimetry.

***BIOCHEM PHYS CHIRAL KIN NMR POLARIM 4**

Applications of NMR to Biochemical Kinetics: A laboratory experiment in physical biochemistry

Drake, E. N.; Brown, C. E.

J. Chem. Educ. 54,124 (1977)

Alpha and beta-D-glucose mutarotation separately studied by change in nmr integration of alpha and beta anomeric protons with time and by polarimetry. Deuterium oxide (D₂O) solvent.

***BIOCHEM INORG NATPROD PORPHYRIN TLC UVIS 2 3**

The Chlorophylls: An experiment in bio-inorganic chemistry

Dujardin, E.; Laszlo, P.; Sacks, D.

J. Chem. Educ. 52,742 (1975)

Bean leaves used as source of chlorophylls. Prepn of Zn(II) and Cu(II) chlorophylls, porphyrin molecule. Identification by tlc, uvis fluorescence. Discussion questions.

***BIOCHEM FLUOR UVIS 5**

Interaction of a Naphthalene Dye with Apohemoglobin

Fancolli, T. M.; Russo, S. F.

J. Chem. Educ. 47,54 (1970)

Preparation of pure hemoglobin dissociation into heme and globin, recombination, and formation and displacement of apohemoglobin-1-anilino-8-sulfonic acid complex studied by uv and filter fluorometer.

***BIOCHEM COLORIMETRY ENZYME KIN NATPROD SEPARATION 2 3**

Tyrosinase: An introductory experiment with enzymes

Friedman, M. E.; Daron, H. H.

J. Chem. Educ. 54,256 (1977)

Tyrosinase is extracted from foods (potatoes, etc.) with a phosphate buffer, and assayed colorimetrically by measuring the rate of conversion of 3,4-dihydroxyphenylalanine(DOPA) to DOPA-chrome.

***BIOCHEM ANAL DEMO ENZYME KIN UVIS 3**

A Demonstration of Enzyme Activity For The "Sceptical Chymist"

Fried, R.; Hows, M.

J. Chem. Educ. 48,847 (1971)

Acetylcholinesterase acts on acetylthiocholine (substrate) in the presence of bis-dithionitrobenzoic acid (chromogen) to yield a yellow anion, which is dialyzed away from enzyme substrate. Thus, reaction can be followed colorimetrically.

***BIOCHEM PHYS INTEGR PROJ 3**

Project-Oriented Physical Chemistry Experiments for Biologists: A Study of Bile Salts

Fung, B. M.; Williams, W.; Smith, R. L.

J. Chem. Educ. 55,198 (1978)

Bile salts used to emulsify fat, solubilize lecithin, fatty acid, cholesterol. Surface tension and micelle formation, acidity, and rate of hydrolysis (crude) also measured. Required: turbidimeter, colorimeter, tensiometer, vapor pressure osmometer.

***BIOCHEM ANAL ELECTROPHOR 3 HAZARD**

Student Experiment With Filter Paper Electrophoresis

Garvin, J. E.

J. Chem. Educ. 38,36 (1961)

Construct 30 volt apparatus, analyze amino acids. Must switch to low-voltage isolation transformer with 24 volt secondary and general-purpose silicon rectifier (1N4004 type). Lethal shock HAZARD with setup described.

***BIOCHEM ANAL TLC 3 HAZARD**

Separation of Leucine and Isoleucine by Thin Layer Chromatography

Gatto, K. L.; Borders, C. L., Jr.

J. Chem. Educ. 47,840 (1970)

For routine analysis of amino acids. MEK-pyridine-water-HOAc. Visualization by ninhydrin (suspected carcinogen).

***BIOCHEM BACTERIA PHARM RADIOCHEM TRACER 4**

Biosynthesis of an Antibiotic: A C-14 tracer experiment

Glover, I. T.; Limbaugh, C. L.

J. Chem. Educ. 46,866 (1969)

Separate cultures of *Aspergillus niger* are grown on media containing 1-*acetate and 2-*acetate. Citrinin isolated is degraded by base hydrolysis and CO₂ produced directly and by oxidation collected as BaCO₃ and counted Geiger or liq. scintillation. A relatively long and elaborate experiments. Extensions.

***BIOCHEM ANAL PHARM SOLUB UVIS 3 4 HAZARD**

Solubility Relationships of Drugs and their Metabolites

Goldsmith, R. H.

J. Chem. Educ. 51,272 (1974)

Salicylic acid-gentisic acid, and benzoic acid-hippuric acid systems used as models to show lipophilic-hydrophilic behavior in drugs and metabolites. FeCl₃-color developer; quant. Spec-20. HAZARD: CHCl₃, used in extraction, is a carcinogen (avoidable).

***BIOCHEM KIN PREP UVIS 3**

Further Experiments with Hemoglobin

Hanson, R. W.

J. Chem. Educ. 58,75 (1981)

Extensions of the experiments described by Russo and Sorstokke (1973), see this bibliography. Describes determination of visible spectra of hemoglobin derivatives, etc. Not a lot of detail, but plenty enough to work up a good experiment, e.g., for an Honors General Chem Lab course.

***BIOCHEM ANAL UVIS 2 HAZARD**

Serum Iron Determination: A sensitive colorimetric experiment

Harris, D. C.

J. Chem. Educ. 55,539 (1978)

Iron reduced (hydroxylamine) and then determined colorimetrically with ferrozine. Ultraclean glass. HAZARD: equine or human blood samples (infection hazard); trichloroacetic acid. Note: ferrozine is an ultra-sensitive reagent for Fe(II); avail. Sigma Chem. Corp.

***BIOCHEM APPARATUS ELECTROPHOR TECHNIQUE UVIS 4 5**

Isoelectrical pH of Hemoglobin and Cytochrome C by Electrofocusing

Heaney, A.; Weller, D. L.

J. Chem. Educ. 47,724 (1970)

Technique experiment for advanced students on purification of proteins.

***BIOCHEM DIALYSIS EXCHANGE RADIOCHEM TRACER 4**

A Laboratory Experiment on Exchange and Binding of Ca-45 by Serum Proteins

Hein, R. E.; Clegg, R. E.

J. Chem. Educ. 33,320 (1956)

Ca-45 counted after dialysis (with mild centrifuging) after equilibration of Ca-45 with serum from chicken blood or bovine albumin.

***BIOCHEM ENZYME KEQ UVIS 4**

Estimation of the Denaturation Equilibrium Constant for Ribonuclease
A Biochemistry Laboratory Exercise

Holladay, L. A.

J. Chem. Educ. 61,1026(1984)

Solutions of bovine pancreatic ribonuclease are treated with guanidinium chloride and the absorbance at 287nm measured. The denaturation equilibrium constant is estimated from a plot of absorbance vs. conc. of guanidinium chloride. Reversibility of denaturation can be demonstrated.

***BIOCHEM PHYS ENZYME KIN UVIS 2 3**

The Hydrolysis of 4-Nitrophenyl Phosphate: A freshman class investigation
Hopkins, H. P., Jr.; Mather, J. H.

J. Chem. Educ. 49,126 (1972)

Hydrolysis measured colorimetrically, as function of pH, and in presence of potato phosphatase, extracted from potatoes. Activation energies from rate studies at 25 deg., 35 deg.

***BIOCHEM APPARATUS MEMBRANE 4**

A Simple Set-Up for Black Lipid Membrane Experiments

Huemoeller, W. A.; Tien, H. T.

J. Chem. Educ. 47,469 (1970)

Formation of membranes described; measured resistance, capacitance. Requires electrometer with multi-speed recorder.

***BIOCHEM IONX TLC 3**

Ion Exchange and Thin Layer Chromatography Separation of Amino Acids

Hurlbut, J. A.; Balka, T. J.

J. Chem. Educ. 55,794 (1978)

Aspartic acid/ arginine separated on cation exchange column followed by TLC for identification. A Chem-Ed compact.

***BIOCHEM PHYS ENZYME KIN UVIS 3**

Two Convenient Spectrophotometric Enzyme Assays: A biochemistry experiment in kinetics

Hurlbut, J. A.; Ball, T. N.; Pound, H. C.; Graves, J. L.

J. Chem. Educ. 50,149 (1973)

Alpha-chymotrypsin-catalyzed cleavage of N-glutaryl-L-phenylalanine-p-nitroanilide followed directly (p-nitroaniline is yellow) or by conversion of this product to an azo compound. Data used to calc. K_m , V_{max} , k_2 . Has been used successfully as a demo at RPI.

***BIOCHEM PHYS ENZYME KIN 2**

Enzyme Activity Experiments Using a Simple Spectrophotometer

Hurlbut, J. A.; Kavianian, G. R.; Lee, S. Y.; Nuttall, K. L.

Gentry, S. R.; Hassman, T. L.

J. Chem. Educ. 54,442 (1977)

Alpha-chymotrypsin reacts with N-glutaryl-L-phenylalanine-p-nitroanilide to produce p-nitroaniline, which is yellow. Hence the reaction may be followed spectrophotometrically (Spec 20). Determination of temperature and pH effects, Michaelis-Menton kinetics, competitive inhibition. Detailed.

***BIOCHEM ANAL DEMO GELC PROJ 2 3**

Gel Filtration Chromatography; A Laboratory Experiment

Hurlbut, J. A.; Schonbeck, N. D.

J. Chem. Educ. 61,1021(1984)

Rapid, visual separation of two highly colored proteins, cytochrome c and ferritin. Reported as a demo., but good project at any level. Can be used to determine mol. wt.

***BIOCHEM IONX UVIS 3 HAZARD**

Separation of Glycohemoglobins by Ion Exchange Chromatography: An undergraduate biochemistry laboratory experiment

Jackman, L. E.

J. Chem. Educ. 58,77 (1981)

Determination of the glycohemoglobin levels of whole blood (HAZARD: infection) by separating the glycohemoglobins from non-glycosylated hemoglobins using cation exchange (BIOREX-70). Details of column preparation given. Preparation of the hemolysate involves the use of a phosphate-KCN buffer (Unlabelled as a HAZARD: toxic, storage hazard). Otherwise, straightforward.

***BIOCHEM ORG CLATH GC UVIS 3**

The Structure and Properties of Choleic Acids: A biologically oriented experiment

Jesaitis, R. G.; Krantz, A.

J. Chem. Educ. 48,137 (1971)

Choleic acids are inclusion complexes of various organic compounds within deoxycholic acid. List of appropriate guest molecules given. Analysis by gc. Example procedure for the naphthalene complex.

***BIOCHEM PHOTO UVIS 5**

Action of Light upon the Visual Pigment Rhodopsin : An experiment in biochemistry

Johnson, R. H.; Williams, T. P.
J. Chem. Educ. 47 ,736 (1970)

Technique experiment for advanced students. Cattle retina, dark room, electronic flash unit (I) Isolation of rod outer segments. (II) Bleaching effectiveness studied by UV, using various filters, times and intensities. Minimal procedure.

***BIOCHEM CONSUMERPROD ELECTROPHOR GELC PROJ 4**

Electrophoretic Analysis of Superoxide Dismutase

Kaars, J.; Kosman, D.
J. Chem. Educ. 60 ,1082(1983)

Superoxide dismutase commercially available or from animal tissues or diet supplement tablets. Uses isoelectric focusing on polyacrylamide gels. Group (four student) expt.; two four-hour periods. Can be extended for projects.

***BIOCHEM PHYS ENZYME KIN UVIS 4**

Two Spectrophotometric Experiments with Alpha-Chymotrypsin

Kantrowitz, E. R.; Eisele, G.
J. Chem. Educ. 52 ,410 (1975)

Mechanism of chymotrypsin catalysis (deacylation of N-trans-cinnamoylchymotrypsin in presence of proflavine) studied using double beam spectrophotometer at 444 nm at various pH's. Activation of chymotrypsinogen in presence of proflavine studied with Spectronic 20.

***BIOCHEM PHYS PORPHYRIN PROJ 3 4**

A Study of Hemoglobin and its Subunits

Kaplan, L. J.
J. Chem. Educ. 53 ,64 (1976)

Many properties including end group analysis of subunits studied in project type experiments. Procedures by reference and by request. Techniques include electrophoresis, enzyme studies, gel and ion-exchange chromatography, viscosity, etc.

***BIOCHEM CHIRAL ENZYME KIN NMR 4**

The Fumarase Reaction: A nuclear resonance experiment for biological chemistry students

Kasperek, G. J.; Pratt, R. F.
J. Chem. Educ. 54 ,515 (1977)

Fumarase catalyzes malate to fumarate equilibrium. In deuterium oxide, measure rate and (by integration) equilibrium constant, measured by nmr spectral changes. Also measure rate of the replacement of a prochiral H by D.

***BIOCHEM DIALYSIS MEMBRANE RADIOCHEM 4 5**

Equilibrium Dialysis : A laboratory experiment

Katz, S. A.; Parfitt, C.; Purdy, R.
J. Chem. Educ. 47 ,721 (1970)

Study of the binding of Hg(II) to human serum albumin. Special dialysis cells. Radiometric assay for Hg.

***BIOCHEM ORG COORD DEMO PROJ 3 HAZARD**

A Simple Demonstration of Reversible Oxygenation

Kildahl, N. K.
J. Chem. Educ. 60 ,898 (1983)

The synthesis of a macrocyclic tetramine diperchlorate and its cobalt (II) complex is briefly presented. The reversible binding of O₂ below 0 C is indicated by a yellow-orange to red color change. Tested Demo suitable for project, but watch the cautions on perchlorate explosions and also the addn. of 70% perchloric acid (HAZARD, not described) in the prep. We would recommend scaling down drastically for project.

***BIOCHEM ANAL RADIOCHEM TECHNIQUE TRACER 5 HAZARD**

A Laboratory Introduction to Competitive Protein Binding and Radioimmunoassay

Kohl, H. H.; Wheatley, W. B.
J. Chem. Educ. 55 ,612 (1978)

Exp't designed to measure level of cortisol in serum or plasma. Liq. scintillation counter, centrifuge, incubator. Warning: blood is an infection hazard. HAZARDS: tritium requires unusual handling and safety precautions; benzene, carcinogen, substitute another solvent.

***BIOCHEM ORG PHARM PREP 3**

A Multidimensional Experiment: Synthesis of a Sulfa Drug and its Use as a Chemotherapeutic Agent

Krantz, A.; Jesaitis, R. G.
J. Chem. Educ. 50 ,76 (1973)

Preparation of sulfanilamide or sulfathiazole (references given) and testing on bacterial cultures (no reference given).

***BIOCHEM ORG BACTERIA GC INTEGR 3**

Microbial Oxidation of Alkenes: An integrated organic-biology experiment
Kumler, P. L.; DeJong, P. J.
J. Chem. Educ. 52,475 (1975)
Culture of p-oleovorans used to epoxidize 1-alkenes: extraction and analysis. Shaking incubation. Epoxide content by GC.

***BIOCHEM DIALYSIS GELC IONX UVIS 3**

The Purification of Cytochrome C from Bakers Yeast: An undergraduate laboratory experiment in biochemistry
Lambeth, D. O.
J. Chem. Educ. 56,270 (1979)
Cell lysis (on pH change, oxidation) is followed by ion exchange, dialysis, uv spectrometry, gel chromatography. Useful for large classes.

***BIOCHEM COLUMNC RADIOCHEM TRACER 4**

Insulin Mediated C-14 -Glucose Incorporation into Adipose Tissue: An undergraduate biochemistry experiment
Landman, A. D.; Eskin, N. A. M.
J. Chem. Educ. 52,479 (1975)
Adipose tissue from sacrificed rat incubated with C-14 -glucose and insulin in shaking bath, homogenized (high speed, motor), extracted, fractionated (column chromatog) and scintillation counted.

***BIOCHEM AFFC RADIOCHEM TECHNIQUE TRACER 4**

The Binding of Biotin to Sepharose-Avidin Column: Demonstration of the Affinity Chromatography Technique
Landman, A. D.; Landman, N. N.
J. Chem. Educ. 53,591 (1976)
Hemoglobin, riboflavin and the dye hydroxyazobenzoic acid (HABA) are eluted sequentially through the sepharose-avidin column with a bicarbonate buffer. This can be followed visually. HABA binds to the attached avidin stoichiometrically. C-14 labelled biotin releases the dye from the column. The biotin is released with guanidine-HCl and the labelled biotin counted by liquid scintillation.

***BIOCHEM ENZYME PROJ REDOX UVIS 4**

Hydride Ion and Sulfite Ion Attack on Pyridine Derivatives: Correspondence between Biochemical and Chemical Reactions as Demonstrated by UV-Spec.
Larsen, P. O.; Sundahl, M.; Wiczorkowska, E.
J. Chem. Educ. 59,1080(1982)
Various substrates and nucleophilic reagents are used to find the limiting structural parameters for the enzymatic and non-enzymatic reduction of NAD+. A nice experiment.

***BIOCHEM AUTORAD NATPROD PAPERC PROJ RADIOCHEM TRACER 4**

Sucrose-C-14 Synthesis in Castor Bean Endosperm Tissue: A tracer experiment
Larson, L. A.
J. Chem. Educ. 43,322 (1966)
Acetate-2 labelled (C-14) incorporated by tissue slices. Exp't follows metabolism of fats in endosperm tissue of germinating castor beans. Radioautography for sugars and amino acids. Assay by Warburg manometer-CO2 or by BaCO3 and end-window Geiger counter. Suitable for a project.

***BIOCHEM ANAL DEMO ELECTROPHOR ENZYME 2**

The Electrophoresis of Indicators: An analogy to isoenzyme separation
Lavalley, D. K.; Daugherty, N. A.
J. Chem. Educ. 56,353 (1979)
Demonstration using crude paper electrophoresis.

***BIOCHEM RADIOCHEM TRACER 4 5**

The Determination of Vitamin D-Dependent Calcium Binding Protein in Chick Intestine: An undergraduate biochemistry laboratory experiment
Lessard, G. M.
J. Chem. Educ. 57,674 (1980)
Protein from intestines of chicks previously kept 6 weeks on a rachitogenic diet isolated by Sephadex chromatography. Protein, compared to normal, shown to bind less Ca++ via use of 45-Ca++ in a Chelex competitive binding assay. Requires animal maintenance, centrifuge, radioactivity measuring equipment.

***BIOCHEM ANAL ORG AFFC CATAL INTEGR PHOTO REDOX TLC 4**

Photooxidation of Methionine: An Integrated Organic-Analytical-Biochemistry Laboratory Experiment
Lewis, C.; Scouten, W. H.
J. Chem. Educ. 53,395 (1976)
Methionine is photooxidized to methionine sulfoxide in the presence of immobilized methylene blue. (1) Porous silica glass beads are activated using germania glycidoxypolytrimethylsilane and p-nitrophenone. (2) p-nitro groups are reduced and diazotized. (3) Methylene blue is coupled to the glass. (4) Methionine is photooxidized with the treated glass as the catalyst. (5) TLC used to determine extent of oxidation.

***BIOCHEM IONX RADIOCHEM TRACER 4**

Isolation and Characterization of Radioactive Adenosinetriphosphate from Mouse Muscle

Lionette, F.; Pastore, E.

J. Chem. Educ. 36,612 (1959)

Research report which might form the basis of a laboratory experiment. Six to eight adult mice were injected w. approx. 100 microcuries of P-32 as the sodium dihydrogen phosphate. The procedure for recovering the P-32 as ATP from the muscle is described in detail.

***BIOCHEM ENZYME KIN UVIS 4**

Cytoplasm-Particle Linked Enzyme Reaction: A laboratory exercise Litwak, G.

J. Chem. Educ. 35,358 (1958)

Standard biochemical laboratory apparatus. Xanthine oxidase, which catalyzes the oxidation of xanthine to uric acid, and uricase, which catalyzes the oxidation of uric acid to allantoin are studied as a linked-enzyme system. The rate of disappearance of the substrate is followed colorimetrically.

***BIOCHEM ORG PHYS KIN UVIS 4**

Kinetics of Imidazole Catalyzed Ester Hydrolysis: Use of Buffer Dilutions to Determine Spontaneous Rate, Catalyzed Rate, and Reaction Order Lombardo, A.

J. Chem. Educ. 59,887 (1982)

Hydrolysis of p-nitrophenol acetate in the presence of imidazole. The reaction is followed by UV absorption spectroscopy.

***BIOCHEM ENZYME NMR PROJ REDOX STRUCTURE 4**

Stereospecificity of NAD⁺/NADH Reactions: A Project Experiment for Advanced Undergraduates

Lowrey, J. S.; Evans, T. A.; Wong, S. S.

J. Chem. Educ. 58,816 (1981)

The project involves the classification of a number of enzymes according to their influence on the stereospecificity of the NAD⁺/NADH reaction; that is, whether an H or a D atom is found at the 4-position on the pyridine after reaction. NMR analysis of the reaction products.

***BIOCHEM ANAL IR NATPROD PAPER 3**

Chemistry of an Insect Wing

McCullough, T.

J. Chem. Educ. 50,101 (1973)

Open-ended experiment begins with measuring IR spectrum of a clean, dry insect wing. Then HCl digestion, TLC, extraction, etc. This is a "first" experiment. Outline only.

***BIOCHEM INORG DIALYSIS ENZYME PREP UVIS 4 HAZARD**

Carbonic Anhydrase and Metallo derivatives. A Bioinorganic Study.

McQuate, R. S.

J. Chem. Educ. 54,645 (1977)

Bovine carbonic anhydrase is converted to apocarbonic anhydrase by dialysis to remove Zn(II). Special precautions to remove contaminating metal ions. Spectrophotometric analysis. Two hundred thirty non-metallo derivatives prepared and analyzed by enzyme catalysis of p-nitrophenylacetate to (yellow) p-nitrophenolate. Several weeks work. Hazard: CCl₄ is a carcinogen: substitute.

***BIOCHEM INORG PHYS ENZYME KIN UVIS 4**

Kinetics of Formation of Cobalt(II)- and Nickel(II) Carbonic Anhydrase

McQuate, R. S.; Reardon, J. E.

J. Chem. Educ. 55,607 (1978)

Apocarbonic anhydrase (preparation from reference) rate of formation of Co(II) and Ni(II) complexes assayed uvis by activity in hydrolysis of p-nitrophenyl acetate.

***BIOCHEM ENZYME GELC KIN UVIS 3**

Isolation of Yeast Invertase by Sephadex Gel Chromatography: A biochemistry laboratory experiment

Melius, P.

J. Chem. Educ. 48,765 (1971)

Chromatographic fractions analyzed for invertase activity by sucrose hydrolysis and 3,5-dinitrosalicylate reagent and for total protein by method referenced. Specific activity, and by further experiments not detailed, enzyme kinetics can be developed.

***BIOCHEM ENZYME KIN UVIS 4**

Activation Energies for a Base-Catalyzed and Enzyme-Catalyzed Reaction

Miller, J. F.; Cory, J. G.

J. Chem. Educ. 48,475 (1971)

Hydrolysis of p-nitrophenyl phosphate catalyzed by (1) base (TRIS buffer), and (2) alkaline phosphatase as a function of temperature Reaction followed by growth of yellow color of p-nitrophenol. (410 nm) Activation energies are very different.

***BIOCHEM ANAL ELECTROPHOR 4**

Determination of the Molecular Weight and Subunit Stoichiometry of a Protein: A biochemistry laboratory experiment
Moe, O. A. Jr.; Smith, G.

J. Chem. Educ. 54,392 (1977)

Hemoglobin, variously crosslinked with dimethylsuberimide (prepn. from suberonitrile given) in electrophoresis on polyacrylamide gel. Requires standard molecular weight proteins, Brilliant Blue R, 2-mercaptoethanol.

***BIOCHEM ORG CONSUMERPROD ENZYME POLARIM PREP PROJ RESOLUTION 3**

An Enzyme-Catalyzed Resolution of Amino Acids

Mohrig, J. R.; Shapiro, S. M.

J. Chem. Educ. 53,586 (1976)

Commercial papain is a catalyst for the stereospecific formation of an insoluble anilide from a racemic benzoylamino acid, prepared from an amino acid and benzoyl chloride. Detailed procedure given. Three lab periods.

Extensions (projects) suggested.

***BIOCHEM ANAL ORG PHARM TECHNIQUE 3**

A Biologically Based Evaluation of Sulfanilamide Purity: A Biological Extension of a Standard Organic Sequential Synthesis

Nelson, G. L.; Buongiorno, P. A.

J. Chem. Educ. 52,676 (1975)

Biochem assay. Nutrient-agar plate inoculated w. Staph. aureus and incubated. Student products tested for anti-bacterial action. Control: reagent-grade sulfanilamide.

***BIOCHEM PHYS ENZYME KIN UVIS 4**

Kinetics of Carboxylesterase

Nichols, C. S.; Cromartie, T. H.

J. Chem. Educ. 56,832 (1979)

Effects of various factors including bis(p-nitrophenyl)phosphate, inactivator, on the rate of hydrolysis of p-nitrophenyl acetate by carboxylesterase. Recording spectrophotometer (400 nm).

***BIOCHEM PHYS ENZYME KIN UVIS 3**

A Kinetic Investigation of an Enzyme-catalyzed Reaction

Nigh, W. G.

J. Chem. Educ. 53,668 (1976)

Fumarase (commercial) catalyzes the interconversion of fumaric acid with L-malic acid under neutral conditions without the need of cofactors.

Forward and reverse reactions followed on a recording spectrophotometer. Data for 10 fumarase substrates given. Extensions suggested.

***BIOCHEM PHYS ENZYME KINETICS UVIS 4 5**

Interaction of alpha-Chymotrypsin with a Strained Cyclic Ester; An Undergraduate Experiment in Transient State Kinetics on a Slow Time Scale
Nitta, Y.; Izbicka-Dimitrejevic, E.; Bolen, D. W.

J. Chem. Educ. 61,929 (1984)

o-Hydroxy-alpha-toluenesulfonic acid sultone hydrolysis is catalyzed by alpha-chymotrypsin. The kinetic scheme includes an enzyme-substrate complex and a covalent intermediate; the work permits quantitating the intermediate conc. Requires two 4-hr. labs and careful calibration and temp. control.

***BIOCHEM PHYS CATAL DEMO ENZYME KIN 3 4**

Lecture Demonstrations in Kinetics Relevant to the Biology Student

Pederson, D. M.

J. Chem. Educ. 51,268 (1974)

Enzyme-catalyzed hydrolysis of o-nitrophenol-(beta)-d-galactopyranoside by beta-galactosidase, followed (Spec 20) by appearance of yellow color of o-nitrophenol. Effect of temperature, substrate conc., mercury.

***BIOCHEM ENZYME MEMBRANE RADIOCHEM TRACER TRANSPORT 3 HAZARD**

Active Transport of Sodium Ions Across Frog Skin

Quinney, P. R.; Swartz, H. A.

J. Chem. Educ. 41,159 (1964)

Na-22 chloride (end window counter) used to measure sodium ion transport. Effect of conc. gradient, lack of oxygen, cyanide ion measured. Not difficult. Hazard: cyanides

***BIOCHEM ENZYME KIN 2**

Bromelain: Experiments illustrating proteolytic enzyme action

Reigh, D. L.

J. Chem. Educ. 53,386 (1976)

Effects on gelation of Jello of the enzyme bromelain obtained from fresh pineapple. Requires centrifuging. Also effect of heat, cold, pH, heavy metal ion and sulfhydryl inhibitors. Extension to other enzymes suggested.

***BIOCHEM DIALYSIS ENZYME EXOBIO KIN UVIS 3**

Thermal Proteinoids: A project in molecular evolution for the undergraduate biochemistry laboratory

Rhodes, G. W.; Flurkey, W. H.; Shipley, R. M.

J. Chem. Educ. 52,197 (1975)

Proteinoids from amino acid (16 neutral and basic plus aspartic and glutamic) at 170-180 degrees, dialyzed, and activity (hydrolysis of paranitrophenyl acetate) compared with that of chymotrypsin.

***BIOCHEM ELECTROPHOR ENZYME 3**

Polyacrylamide Gel Electrophoresis of Yeast Invertase: A biochemistry laboratory experiment

Roberts, C. A.; Jones, C.; Spencer, E. J.; Bowman, G. C.; Blackman, D. J. Chem. Educ. 53, 62 (1976)

Yeast invertase purification on sephadex or biogel described separately is followed by gel electrophoresis of crude and partially purified materials. Assay by hydrolysis of sucrose acetate and color reaction with 3,5-dinitrosalicylate.

***BIOCHEM ENZYME KIN UVIS 3**

The Mechanism of Action of Salivary Amylase: A simple undergraduate experiment

Rungtuanasak, K.; Panijpan, B. J. Chem. Educ. 56, 423 (1979)

Saliva hydrolysis of potato starch solution followed by reaction of maltose with dinitrosalicylic acid. Kinetics used to establish mechanism.

***BIOCHEM ANAL ENZYME FLUOR 4**

Two Fluorescence Experiments

Russo, S. F.

J. Chem. Educ. 46, 374 (1969)

Fluorescence quantum yield of unknown (fluorescein) by comparison with fluorescence excitation spectrum of quinine. Fluorescence labeling of protein uses 2-p-toluidinylnaphthalene-6-sulfonate and chymotrypsin.

***BIOCHEM ENZYME FLUOR 3**

Assay for Angiotensin-Converting Enzyme

Russo, S. F.

J. Chem. Educ. 60, 779 (1983)

Human blood plasma or serum is assayed for angiotensin-converting enzyme (ACE) using p-nitrobenzyloxy-Gly-Trp-Gly and fluorescence. Good discussion of background. CONTAGION WARNING

***BIOCHEM ENZYME KIN UVIS 3**

The Activity of Trypsin

Russo, S. F.; Holzman, T.

J. Chem. Educ. 54, 60 (1977)

Trypsin activity measured by hydrolysis of methylated casein. Rates used to calculate specific, molar, and catalytic center activity. Trinitrobenzenesulfonic acid.

***BIOCHEM DEMO PORPHYRIN UVIS 2**

Hemoglobin: Isolation and chemical properties

Russo, S. F.; Sorstokke, R. B.

J. Chem. Educ. 50, 347 (1973)

Oxyhemoglobin solution isolated from lysed blood cells, visible spectrum examined after reaction with ferrous sulfate, ferricyanide, nitrite, and pH variation. See Hanson, R.W., J. Chem. Educ. 58, 75 (1981).

***BIOCHEM PHYS ENZYME KIN UVIS 4 HAZARD**

Determination of Rate Constants for Ouabain Inhibition of Adenosine

Triphosphatase: An undergraduate biological chemistry laboratory experiment

Sall, E.; Givens, C. D.; Taylor, R. P.; Grisham, C. M.

J. Chem. Educ. 55, 122 (1978)

ATP-ase (from sheep kidney), activity measured uvis by NAD⁺ produced in coupled enzyme reactions of pyruvate kinase and lactate dehydrogenase.

HAZARD: ouabain is an extremely toxic heart and nervous system poison.

***BIOCHEM GELC PREP 3**

Isolation of Soybean Agglutinin (SBA) from Soy Meal

Satsangi, P. D.; Satsangi, S.; Grossman, H. H.

J. Chem. Educ. 59, 977 (1982)

Flowchart and detailed procedure for separation and assay.

***BIOCHEM APPARATUS COMPUTER KEQ PORPHYRIN UVIS 5**

Demonstration of Allosteric Behavior: The hemoglobin-oxygen system

Sawyer, W. H.

J. Chem. Educ. 49, 777 (1972)

Diagram of a simple apparatus for equilibrating hemoglobin with known partial pressures of oxygen (tonometer). Evans Electroselenium Colorimeter, 600 nm filter. The point of the experiment is to demonstrate allosteric characteristics and the effect of modifiers such as protons and organic phosphates. Thermodynamic interpretation allows computer simulation of binding phenomenon.

***BIOCHEM ELECTROPHOR EXOBIO PAPER 3**

A Biochemistry Laboratory Experiment

Scher, I.; Walsh, E.; Kadis, B.

J. Chem. Educ. 38, 632 (1961)

Miller experiment. Amino acids from electric discharge in natural gas. Special glass apparatus.

***BIOCHEM ANAL LUMIN UVIS 3 HAZARD**

Detection of ATP and NADH

A Bioluminescent Experience

Selig, T. C.; Drozda, K. A.; Evans, J. A.

J. Chem. Educ. 61,918 (1984)

Firefly luciferase is used to assay ATP and bacterial luciferase is used to assay NADH. The amount of light emitted is proportional to the limiting substrate conc. (ATP or NADH) and is measured using a Turner UV-visible spectrophotometer. HAZARD: mercaptoethanol is toxic.

***BIOCHEM ANAL FLUOR NATPROD VITAMIN 3**

Excretion of Ingested Ascorbic Acid: An easy interesting undergraduate experiment

Sirota, G. R.; Macinnis, W. K.; Rasmussen, P. W.

J. Chem. Educ. 56,421 (1979)

React o-phenylenediamine, measure filter fluorometer.

***BIOCHEM 4**

Hemoglobin: A Series of Biochemistry Experiments

Slabaugh, M. R.; Carrasco, C. R.

J. Chem. Educ. 52,67 (1975)

A listing only; details from authors.

***BIOCHEM NOPROC PORPHYRIN PROJ 5**

Hemoglobin as a System for Laboratory Study

Splittergerber, A. G.

J. Chem. Educ. 51,402 (1974)

Centrifuging, lysis, dialysis gives stock hemoglobin solution. Use for pH titrations, viscosity, electrophoresis, tyrosine and tryptophan analysis (uvis), paper and column chromatography, oxygen binding by Warburg, magnetic susceptibility, molecular weight by iron analysis, kinetics of autoxidation to methemoglobin.

***BIOCHEM PHYS AFFC KIN UVIS 3**

The Kinetics and Inhibition of the Enzyme Methemoglobin Reductase: A biochemistry experiment

Splittergerber, A. G.; Mitchell, K.; Puffer, G. D. M.; Blomquist, K.

J. Chem. Educ. 52,680 (1975)

Washed (centrifuge) red blood cells lysed in water. Crude enzyme on DEAE cellulose, extracted, assayed by reduction of 2,6-dichlorophenol indophenol in presence of NADH. Kinetics studied also with salicylate inhibition.

Michaelis-Menton kinetics. For DEAE cellulose, ref. J. Biol. Chem (1962).

***BIOCHEM PHYS APPARATUS NUCLACID UVIS 3**

The Helix-Coil Transition of DNA: Observed With an Inexpensive UV Photometer

Steinert, R.; Hudson, B.

J. Chem. Educ. 50,129 (1973)

DNA in random coil absorbs approx. 40% more intensely than in double helix at 260 nm. Increase usually occurs 60-100 deg. C. Expt. requires UV photometer with var. temp. cell - design given. Calf thymus DNA.

***BIOCHEM EXOBIO 2 3**

A "Primordial Biogenesis" Experiment

Steinman, G.; Smith, A. E.

J. Chem. Educ. 45,555 (1968)

Formaldehyde and ammonium thiocyanate react to form dynamic microscopic bodies, by incubation or UV irradiation. Elements of structure. Little explanation.

***BIOCHEM PHYS KEQ KIN UVIS VITAMIN 3**

Thermodynamics and Kinetics of Ligand Binding to Vitamin B12a: A laboratory experiment

Sweigart, D. A.

J. Chem. Educ. 52,126 (1975)

Keq for Vitamin B12a reaction with SCN measured uvis. Also rate constants measured by stopped flow used to calculate Keq.

***BIOCHEM ENZYME FLUOR RADIOCHEM TECHNIQUE TLC 4 HAZARD**

Yeast Metabolism of D-(U-14C)-Glucose: A Student Study of the Early Stages of Glycolysis

Taber, R. L.; Harwood, B. G.

J. Chem. Educ. 60,249 (1983)

D-(U-14C)-Glucose is metabolized by yeast for 3 seconds and the phosphorylated sugars separated by TLC. Activity of fructose-6-diphosphate, glucose-6-phosphate, fructose-6-phosphate and glucose are determined by liquid scintillation counting or fluorography. Use of radioisotopes requires a good hood and special handling techniques.

***BIOCHEM DEMO ENZYME 4**

A Simple Method for Demonstrating an Enzymatic Reaction

Tang, C. S.

J. Chem. Educ. 47,692 (1970)

Papaya seeds. Caution: taste test, probably OK as a demo well away from the lab, but be sure of the origin of seeds.

*BIOCHEM ANAL CHROMATOG ENZYME TLC UVIS 3

Enzymatic and Colorimetric Determination of Total Serum Cholesterol:
An undergraduate biochemistry laboratory experiment

Taylor, R. P.; Broccoli, A. V.; Grisham, C. M.

J. Chem. Educ. 55,63 (1978)

Blood serum incubated with mixed enzymes (cholesterol ester hydrolase, cholesterol oxidase, peroxidase) and phenol and 4-aminopyrene. Optical density at 500 nm measured (standardized with cholesterol). Alternative: serum plus Liebermann-Burchard reagent, optical density at 625 nm. Enzyme assay products examined with tlc.

*BIOCHEM AFFC ELECTROPHOR ENZYME KIN NOPROC TECHNIQUE UVIS 4

Affinity Chromatography of Lactate Dehydrogenase: A biochemistry experiment

Taylor, S. S.; Dixon, E.

J. Chem. Educ. 55,675 (1978)

AMP-sepharose prepared or available commercially used to isolate a family of enzymes (dehydrogenases), separated from beef heart or rabbit muscle. Separation of lactate dehydrogenase by elution with NADH-pyruvate adduct. Enzyme assay by NADH oxidation (uv) in presence of pyruvate. Molecular weight by gel electrophoresis or sephadex column chromatog. Kinetics and electrophoresis to distinguish isoenzymes.

*BIOCHEM ANAL PHYS ENZYME KIN UVIS 3

Determination of Glucose: A kinetics experiment for the analytical course

Toren, E. C., Jr.

J. Chem. Educ. 44,172 (1967)

Glucose oxidase, followed by horseradish peroxidase-o-dianisidine reaction used for kinetic data; two methods of analyzing data give glucose concentration.

*BIOCHEM TECHNIQUE 3 HAZARD

Equilibrium Density Gradient Centrifugation for Introductory Biochemistry

Vermeulen, C. W.

J. Chem. Educ. 59,1079(1982)

Isopycnotography without Cs salts. E. coli in aq. NaBr. Schematic diagram of the preparation of the density-gradient. HAZARD: the internal standards used are benzene and chloroform in milliliter quantities.

*BIOCHEM COMPLEX ENZYME IONX UVIS 4

Comparison of Formation Constants for Nucleotide-Polyamine and Nucleotide-Magnesium Complexes

Voige, W. H.; Elliot, R. I.

J. Chem. Educ. 59,257 (1982)

Buffered mixtures of ADP with polyamine or MgCl₂ and anion-exchange resin are incubated with periodic mixing. ADP complexes remain in solution, but uncomplexed ADP binds to the resin - the amount bound is proportional to the concentration of free nucleotide. After incubation, the resin is centrifuged off and the nucleotide conc. determined spectrophotometrically.

*BIOCHEM ORG BACTERIA ENZYME INTEGR PHARM PREP TLC 3

The Microbial Hydroxylation of Progesterone: An organic-biological experiment involving a reaction important to the pharmaceutical industry

Volker, E. J.

J. Chem. Educ. 54,65 (1977)

Culture of *Rhizopus nigricans* hydroxylates 10-100 mg of progesterone, determined by tlc or recrystallization and ir, requires autoclave shaker.

*BIOCHEM ORG BACTERIA CHIRAL POLARIM PREP 3

The Microbial Conversion of D-Sorbitol to L-Sorbose: An interdisciplinary experiment illustrating an industrial process

Volker, E. J.; Shultz, C.

J. Chem. Educ. 55,673 (1978)

Acetobacter suboxydans culture used to oxidize D-sorbitol. Aliquots withdrawn for polarimetry.

*BIOCHEM ANAL ACBA NMR TITN 4

Titration of Alanine Monitored by NMR Spectroscopy:

A Biochemistry Laboratory Experiment

Waller, F. J.; Hartman, I. S.; Kwong, S. T.

J. Chem. Educ. 54,447 (1977)

Simultaneous monitoring of pH and NMR proton shifts during the acid-base titration of alpha- and beta-alanine. Calculation of pK(NH₃⁺) values. See also Burt,C.T., J. Chem. Ed. 59, 1056(1982).

*BIOCHEM DEMO REDOX 3

Transferrins-Illustrative Metal-Binding Proteins

Webb, J.; VanBockxmeer, F. M.

J. Chem. Educ. 57,639 (1980)

Demonstration of a metal-protein interaction. Sprinkle FeSO₄·7H₂O crystals on a freshly-prepared saline solution of egg white: the orange-pink color of the ferric protein complex appears in approx. 15 sec, is fully developed in 2 minutes. Maybe a basis for extension to other proteins?

***BIOCHEM COLUMNC ENZYME GC TLC 3 HAZARD**

Egg Yolk Lecithin: A biochemical laboratory project

White, B. J.; Tipton, C. L.; Dressel, M.

J. Chem. Educ. 51,533 (1974)

Phosphatide mixture by solvent extraction analyzed by tlc. Lecithin separated column chromatography. Hydrolysis with phospholipase-A (snake venom - HAZARD) and by KOH followed by esterification (BF₃-methanol) for gc analysis of fatty acids.

***BIOCHEM PHYS ENZYME NUCLACID PROJ UVIS 4 HAZARD**

Isolation and Characterization of Bacterial DNA: A project-oriented laboratory in physical biochemistry

Wilson, W. D.; Davidson, M. W.

J. Chem. Educ. 56,204 (1979)

Frozen E. coli B cells (commercially available), treated lysozyme, sodium lauryl sarcosine, proteinase K, and DNA separated by centrifuge, treated ribonuclease A, extracted with phenol (hazard) and separated by centrifuge, dialyzed and analyzed by uvis. Characterizations (described by reference) includes uvis spectrum, helix-coil transition temperature and hyperchromicity, RNA determination, gel electrophoresis and viscosity.

***BIOCHEM ENZYME KIN 6**

Determination of the Kinetic Constants in a Two-Substrate Enzymatic Reaction

Yap, W. T.; Howell, B. F.; Schaffer, R.

J. Chem. Educ. 54,254 (1977)

Research report. Kinetics of the reaction of pyruvate with reduced nicotinamide adenine dinucleotide (NADH) catalyzed by the enzyme lactate dehydrogenase (LDH) studied. A method is given for the analysis of that part of the kinetic data which involves initial velocities as a function of substrate concentration. This provides an accurate method of determining kinetic constants in two-substrate enzymatic reactions.

***INORG COORD PREP PROJ UVIS 2**

The Synthesis and Reactions of a Cobalt Complex: A project for freshman laboratory

Alexander, J. J.; Dorsey, J. G.

J. Chem. Educ. 55,207 (1978)

Tetraamminecarbonatocobalt(III) complex from cobalt nitrate followed by reaction with unknown strong acid to yield compound identifiable from vis spectrum.

***INORG PHYS DEMO GAS KEQ PREP 2**

Gas Laws, Equilibrium, and The Commercial Synthesis of Nitric Acid: A simple demonstration

Alexander, M. D.

J. Chem. Educ. 48,838 (1971)

Simple apparatus. Reactant gases are NO and O₂.

***INORG ORG NMR ORGANOMETAL PREP 4 HAZARD**

Synthesis and NMR Spectrum of Triphenyltin Hydride

Allen, C. W.

J. Chem. Educ. 47,479 (1970)

Tetraphenyl tin and anhy. SnCl₄ form triphenyltin chloride. Reduction in anhy. NH₃ with Li gives product; dist. at 0.1mm. HAZARD: tin toxicity, liq. NH₃, lithium metal.

***INORG DEMO ELECTROCHEM MOLTENSALT PROJ 1 3 HAZARD**

Sodium Through Glass: A Lecture Demonstration Experiment Involving Electrons, Ions, and Atoms

Alpern, D. K.

J. Chem. Educ. 34,289 (1957)

Sodium ions travelling through glass wall of an incandescent light bulb are reduced to the metal by electrons from the filament. Unusual electrolysis experiment uses molten sodium nitrate as the electrolyte; electrical circuit through wire connected to bulb. HAZARDS: electrical shock; nitrate melts must be protected from contact with carbon-containing compounds, other reducibles. Setup shown is not protected from spills, breakage. Explosive.

***INORG ORG IR MASSPEC NMR ORGANOMETAL PREP 4 5 HAZARD**

Preparation and Characterization of Mesitylene Tricarbonyl Molybdenum (O): An experiment in organometallic chemistry

Angelici, R. J.

J. Chem. Educ. 45,119 (1968)

From molybdenum hexacarbonyl. Lower-cost prep for senior lab course. The compound is prepared, purified, and examined by ir, nmr, etc. Caution: highly reactive, toxic materials.

***INORG APPARATUS COORD GAS NONAQ PREP 4**

Oxygen Uptake by a Cobalt(II) Complex: An Undergraduate Experiment
Appleton, T. G.

J. Chem. Educ. 54, 443 (1977)

Simple apparatus described for measuring the oxygen uptake of the N,N' -bis(salicylaldehyde)ethylenediamine complex of Co^{++} in DMSO.

Preparations are given both for the complexing agent and the complex.

***INORG ORG COMPLEX EXCHANGE NMR ORGANOMETAL PREP 4 5 HAZARD**

Exchange Reactions by NMR Without Variable Temperature: An Experiment Using Allyl-Palladium Complexes

Appleton, T. G.; Cotton, J. D.

J. Chem. Educ. 55, 131 (1978)

Prep. of $Na_2PdCl_4 \cdot (Pd(Pi-(C_4H_7)Cl)_2$ and $Pd(Pi-C_4H_7)Cl-P(C_6H_5)_3$ from palladium sponge. Pi -allyl system from methylal chloride. Nmr spectrum changes with (Pd/P) ratio. HAZARD: carbon monoxide (toxicity).

***INORG DTA MAGNETIC NOPROC PHOTO PREP PROJ 4**

Preparation and Properties of Potassium Trioxalatoferate(III) Trihydrate: a Laboratory Exercise

Aravamudan, G.; Gopalakrishnan, J.; Udupa, M. R.

J. Chem. Educ. 51, 129 (1974)

Describes use of compound named in title as basis of graduate school project. No details, but ref. to J. Chem. Educ. 47, 702(1970) for preparation. Within capacity of many university freshmen.

***INORG COORD GLOBE IR NMR 4 5 HAZARD**

Synthesis of Dinitrogen and Dihydrogen Complexes of Molybdenum

Archer, L. J.; George, T. A.; Noble, M. E.

J. Chem. Educ. 58, 727 (1981)

One-step method for initial complex takes 10+ hours, but is still briefer than previous methods. Conversion to a second complex can be done in 1 hour. HAZARD: benzene.

***INORG DEMO REDOX 2**

A Lecture Demonstration of the Various Oxidation States of Manganese

Arora, C. L.

J. Chem. Educ. 54, 302 (1977)

Demonstration solutions of less common valences are prepared by reacting the more common ones; e.g., $Mn(III)$ is prepared by mixing MnO_4^- and $Mn(II)$ in conc. H_2SO_4 . Detailed presentation of the relevant half-reactions. A tested demonstration.

***INORG COORD NOPROC 2 HAZARD**

A Further Improvement on the Copper Cycle Experiment

Bailar, J. C.

J. Chem. Educ. 60, 583 (1984)

Short note (see Umans & deVos J. Chem. Ed 59,52(1982)) describes copper cycle ($Cu(0)$ to $Cu(+2)$ to $Cu(+1)$ to $Cu(0)$) where reactions are distinguished by color changes. HAZARD: uses gaseous hydrogen to reduce copper(II) to $Cu(I)$.

***INORG ORG DEMO MAGIC 1**

Producing a Chemistry Magic Show

Bailey, P. S.; Bailey, C. A.; Anderson, J.; Koski, P. G.; Rechsteiner,

J. Chem. Educ. 52, 525 (1975)

Demonstration suggestions, some new.

***INORG ORG COORD INTEGR MAGNETIC PREP SEQ 4 HAZARD**

Electronic Properties of Manganese Isocyanide Complexes by NMR

Bailey, R. A.

J. Chem. Educ. 49, 297 (1972)

Synthetic sequence begins with prep'n of pure $Mn_2O_3 \cdot 2H_2O$ from $MnCO_3$ and anhydrous HI ; and prep'n t -butyl isocyanide from t -butyl formamide.

Hexakis(t -butylisocyanide) $Mn(I)$ nitrate and hexakis(t -butylisocyanide)- $Mn(II)$ fluorophosphate prep'd, and magnetic moments measured. Does not require vacuum line or inert atmosphere.

Hazard: highly exothermic $POCl_3$ reaction - not for beginners.

***INORG PREP REVIEW HAZARD**

Some Experiments in Sulfur-Nitrogen Chemistry

Banister, A. J.; Smith, N. R. M.

J. Chem. Educ. 59, 1058(1982)

Paper reviews main structural types of sulfur-nitrogen compounds, and gives detailed preparation methods for typical complexes, including "metallike" $(SN)_x$. Some special glassware needed. Diagrams of glassware set-ups, and HAZARD warnings included. 34 references.

***INORG ELECTROANAL ISOMERS PREP TITN UVIS 3 HAZARD**

The Hydration Isomers of Chromium(III) Chloride

Barbier, J. P.; Kappenstein, C.; Hugel, R.

J. Chem. Educ. 49, 204 (1972)

Commercial and two other (prepared) isomers examined: spectra, conductance, chloride ion (by mercurimetric titn) concn. HAZARD: $HCl(gas)$.

***INORG GLOVEB ORGANOMETAL PREP PROJ SEQ 4 HAZARD**

Nickel Complexes With Organic and Phosphorous Ligands: an Integrated Set of Inorganic Experiments

Barnett, K. W.

J. Chem. Educ. 51,422 (1974)

Nickelocene, etc. synthesis. Preparation details are given, but little on characterization. HAZARD: highly toxic compounds.

Extensions suggested, no details.

***INORG DEMO GAS SOLUB 2**

The Solubility of Ammonia

Barrett, R. L.

J. Chem. Educ. 36 ,A61 (1959)

Variation on the ammonia fountain. A Chem-Ed Tested Demo.

***INORG DEMO PREP 2**

Preparation of Chromate, Manganate, and Permanganate

Barrett, R. L.

J. Chem. Educ. 36 ,A68 (1959)

A Chem-Ed Tested Demo. MnO_2 , Cr_2O_3 fused with $NaOH-KNO_3$, and the cooled mass dissolved in water to show (yellow) chromate ion, (green) manganate ion. Acidification of the manganate solution with HNO_3 (6M) will result in its conversion to (purple) permanganate.

***INORG DRYLAB SIMULATION STOICH TITN 2**

FORMULA: A Simulated Experiment in Beginning Chemistry

Bendall, V. I.; Powell, H.; Taylor, M.

J. Chem. Educ. 59 ,599 (1982)

Computer simulation (Microsoft BASIC) of determination of weight loss on heating potassium chlorate and titration for chloride in the residue.

***INORG PHYS DENSITY 2 HAZARD**

The Density of a Single Crystal of Ammonium Oxalate Monohydrate by the Flotation Method

Bergendahl, T. J.

J. Chem. Educ. 56 ,617 (1979)

Mixed solvent method uses acetone - carbon tetrachloride (HAZARD: should be possible to substitute).

***INORG ELECTROCHEM REDOX 2**

Anodizing Aluminum: An Electrolytic Oxidation Experiment For General Chemistry

Blatt, R. G.

J. Chem. Educ. 56 ,268 (1979)

Author proposes anodization 10 V DC in 28% sulfuric acid, coloring anodized surface w. bright fabric dyes. Reader (VC) says 28% sulfuric does not work, but 10% is all right. Bibliographers suggest use of basic electrolyte.

***INORG ACBA DEMO 1 HAZARD**

Chromate-Dichromate Equilibrium

Bohning, J. J.

J. Chem. Educ. 37 ,A44 (1960)

Dichromate and chromate solutions are reacted with H^+ , OH^- , Ag^+ , and Ba^{++} , to demonstrate the ($2CrO_4 = /Cr_2O_7 =$) acid-base equilibrium. A Chem. Ed. Tested Demo. HAZARD: $Cr(+6)$ is a carcinogen.

***INORG MISTAKE PREP REDOX 3 HAZARD**

Isolation of Uranium by Reduction of Uranyl Acetate

Bonsper, T.

J. Chem. Educ. 53 ,515 (1976)

Simple apparatus, complex reaction. Step 1, UO_3 from uranyl acetate by calcium reduction. Step 2. Reduction to metal with carbon. HAZARDS: radioactivity; use of sodium if calcium is not sufficient to reduce; one disposal method is wrong.

***INORG ESR PREP 4 5**

An EPR Study of Vanadyl Complexes for Advanced Undergraduate Laboratory

Borer, L. L.

J. Chem. Educ. 59 ,1065(1982)

Study of two vanadium(IV) complexes, one purchased, the other prepared (references given; air sensitive).

***INORG COMPLEX DEMO IR PREP 3**

Spectroscopy Illustrated: A Lecture Experiment

Boschmann, E.

J. Chem. Educ. 59 ,57 (1982)

Prep. of $CuCl_2 \cdot 2DMSO$, $SnCl_2 \cdot 2DMSO$, and $PbCl_2 \cdot 2DMSO$ (over 4 hrs), and use of IR for structure. Caution is required in using DMSO. Seems to us a good student experiment and a poor demo.

*INORG COMPLEX COORD DEMO IR PREP 3 HAZARD

Spectroscopy Illustrated

Boschmann, E.; Wollaston, G.

J. Chem. Educ. 60, 413 (1983)

A Tested Demonstration. Prep'n of DMSO adducts of CuCl_2 , SnCl_4 , PdCl_2 .

IR analysis (suggested procedure) gives bonding site (O or S).

Hazard warning in article on handling DMSO.

*INORG DEMO NAME THERMO 2 HAZARD

The Thermite Lecture Demonstration

Bozzelli, J. W.; Barat, R. B.

J. Chem. Educ. 56, 675 (1979)

Straightforward. Two modifications to standard set-up to make implementation simpler, and to increase audience accessibility.

HAZARD: glycerol-permanganate igniter (explosive hazard).

*INORG CHEM.ENG COMPLEXIM CONSUMERPROD DEMO DISTRIB REDOX SEPARATION

The Extraction of Gold and its Simulation with Copper

Bradley, J. D.; Brand, M.; Loulie, J. A. M.

J. Chem. Educ. 61, 634 (1984)

The industrial chemistry of extraction of gold is described but not recommended because it requires use of cyanide. The expt. with copper involves extraction with ammonia (shown to be slow unless additional oxidant, H_2O_2 , is added) and then deposition by reaction with zinc. A Filtrates and Residues selection.

*INORG CLOCK COLOR DEMO KIN REDOX 1 2

Rossini, William Tell and the Iodine Clock Reaction: A Lecture Demonstration

Brice, L. K.

J. Chem. Educ. 57, 152 (1980)

Excerpts from William Tell Overture add student interest to standard iodine clock reaction.

*INORG CRYSTAL FLUOR PHOSPHOR PREP UVIS XRAY 4 5

On the Structural and Luminescent Properties of the $\text{ScTa}(1-x)\text{Nb}(x)\text{O}_4$ System

Brixner, L. H.

J. Chem. Educ. 57, 588 (1980)

Prep. requires sublimation in HCl stream, 1500C furnace, ball mill, powder

diffraction camera.

*INORG DEMO PREP 2 HAZARD

Preparation of White Phosphorus From Red Phosphorus

Brodkin, J.

J. Chem. Educ. 37, A93 (1960)

By heating red phosphorus in a test tube. White phosphorus condenses on a cold-finger. A Chem-Ed Tested Demo. HAZARD: white phosphorus is highly toxic, gives bad burns, and is a storage and disposal hazard. This demo is not suitable for adaptation to a student experiment.

*INORG ANAL COORD NOPROC PREP REDOX SEQ 2

An Experiment Sequence Involving Potassium Trioxalatoferrate(III) Trihydrate

Brooks, D. W.

J. Chem. Educ. 50, 218 (1973)

Describes exp. seq. for prep and anal. Zn-dust reduction avoids Hg waste.

*INORG DEMO 2 HAZARD

Reduction of Cupric Ion by White Phosphorus

Bryce, W. A.

J. Chem. Educ. 35, A26 (1958)

A Chem-Ed Tested Demo. HAZARD: white phosphorus is toxic and generally considered a dangerous substance. (burns, storage hazard). This demo is not suitable for adaptation to a student experiment.

*INORG COORD NOPROC PREP SEQ 3

Multipurpose Coordination Chemistry Experiment for Undergraduates

Burnmeister, J. L.

J. Chem. Educ. 44, 768 (1967)

3-step synth. of $\text{K}_3(\text{Co}(\text{CN})_5\text{SCN})$ requires student to follow lit. directions and modify them. No characterization except grav. anal. and ir mentioned.

*INORG COORD IR NMR VACTEK 4 5 HAZARD

Reactions of a Dinitrogen Complex of Molybdenum: Formation of a Carbon-Nitrogen Bond

Busby, D. C.; Fendrick, C. M.; George, T. A.

J. Chem. Educ. 58, 728 (1981)

Continuation of Archer, R.J.; George, T.A.; Nobel, M.E., J. CHEM. EDUC., 58, 727 (1981). Conversion of complexes to other complexes. HAZARD: benzene.

***INORG ELECTROCHEM PROJ 4 HAZARD**

Recovery of Silver From Laboratory Wastes

Bush, K. J.; Diehl, H.

J. Chem. Educ. 56, 54 (1979)

Electrodeposition from cyanide solution. Suitable for student project, with care. HAZARD: cyanides, cyanogen (possible).

***INORG CORROSION DEMO REDOX 2**

Controlled Corrosion of Iron

Byrne, R.

J. Chem. Educ. 36, A41 (1959)

A Chem-Ed Tested Demo. Visualization of products of corrosion of iron by surrounding iron electrodes with a agar gel doped with $K_3Fe(CN)_6$ and phenolphthalein ("ferroxyl indicator").

***INORG PHYS ACBA DEMO ELECTROCHEM 2**

A Comparison of Base Strengths Using Visual and EMF Observations

Campbell, J. A.

J. Chem. Educ. 52, 185 (1975)

Copper(II) solutions give precipitates with various anions. Base strengths estimated by competitive reactions, then measured with copper electrode and zinc reference electrode. For instructors only. CAUTION: avoid cyanides.

***INORG COORD DEMO KIN REDOX 2 HAZARD**

Illustration of d and p Block Element Properties

Canty, A. J.

J. Chem. Educ. 55, 790 (1978)

Soln of $AgCl$ in NH_3 , $NaCN$ (aq), and reduction of complexes to free metal. HAZARD: Cyanides.

***INORG ORGANOMETAL PREP TLC 4 5 HAZARD**

Organometallic Chemistry of Mercury - An Undergraduate Experiment

Canty, A. J.

J. Chem. Educ. 51, 750 (1974)

Phenyl mercuric halides prepared from benzene by mercuric acetate reaction, TLC in detail. Characterizations (ir, nmr) mentioned. HAZARD: toxic compounds, disposal problems, carcinogens.

***INORG STOICH 2**

The Determination of the Combining Weight of Tin

Carmody, W. R.

J. Chem. Educ. 44, 416 (1967)

Modified procedure for an old experiment gives results to 1%.

***INORG STOICH 1**

A Study of the Silver Tree Experiment

Carmody, W. R.; Wiersma, J.

J. Chem. Educ. 44, 417 (1967)

Systematic errors leading to poor results in the CHEMS program analyzed and a modified apparatus and procedure suggested.

***INORG DEMO PREP 2 HAZARD**

The Aluminothermic Process: A variation

Chakoumakos, C.

J. Chem. Educ. 36, A21 (1959)

A Chem-Ed Tested Demo. Thermite reaction under safer conditions than was common in 1959, but still not very safe. HAZARD: high temperature, possible explosion.

***INORG PREP STOICH 1**

The Relationship of Lead and Sulfur in a Chemical Reaction

Chapman, V. L.

J. Chem. Educ. 54, 436 (1977)

Direct combination of the elements. Teaching suggestions. Caution: Sulfur dioxide vapor evolved - perform in hood.

***INORG ANAL MAGNETIC NOPROC PREP PROJ SOLID XRAY 4**

Normal and Inverse Ferrite Spinel: A set of solid state chemistry related experiments

Chaumont, C.; Burgard, M.

J. Chem. Educ. 56, 693 (1979)

Preparations require muffle furnace. Magnetic properties. Extensions.

***INORG ACBA CLATH DISTRIB IR MACROCYCLE NMR PREP 3 HAZARD**

Preparation of a Stoichiometric Complex of Hydronium Tetrafluoroborate and 18-crown-6 by Phase Transfer

Chenevert, R.; Rodrique, A.

J. Chem. Educ. 61, 465 (1984)

Preparation of $H_3O.BF_4.18\text{-crown-6}$. Characterization of product by IR, NMR and titration with base. HAZARD: 18-crown-6 is toxic.

*INORG GLASS HITEMP SOLID 2 3

Raku: A Redox Experiment in Glass Chemistry

Cichowski, R. S.

J. Chem. Educ. 52,616 (1975)

Raku is an old Japanese ceramic process—colored and decorative surface on glass by reduction of copper or silver. Requires muffle furnace in hood. A nice combination of chemistry and art. Caution: high temperature work requires spec. precautions.

*INORG PHYS DEMO ELECTROCHEM PREP 2

Preparation of Sodium by Electrolysis of Solid Sodium Hydroxide

Ciparick, J. S. J.

J. Chem. Educ. 37, A35 (1960)

A Chem-Ed Tested Demo; requires an electrolysis demonstration apparatus, Cu electrodes, 120 volt DC source.

*INORG ANAL NOPROC PREP 3

A Study of Ammonium Carbamate: A Student Project

Clifford, C. W.

J. Chem. Educ. 43,104 (1966)

Preparation from ammonia (gas and liquid) and CO₂ (gas), and from NH₃ (liquid) and CO₂ (solid). Analysis by absorption in sulfuric acid and sodium hydroxide.

*INORG PREP SEQ 2

Near 100% Student Yields With The "Cycle of Copper"

Condike, G. F.

J. Chem. Educ. 52,615 (1975)

Seq. is: Cu converted to Cu(NO₃)₂ by dissolving in acid, to Cu(OH)₂ by reaction with NaOH, etc. back to Cu. Description only - v. few details. WARNING: assorted standard hazards, such as conc. acids (e.g., H₂SO₄, HNO₃), H₂ evolution, etc., not identified. Insufficient detail for beginners.

*INORG ELECTROCHEM HITEMP PREP STOICH VACTEK XRAY 4 5

The Preparation and Characterization of Sodium Tungsten Bronze

Conroy, L. E.

J. Chem. Educ. 54,43 (1977)

Tungsten bronze by electrochem or chemical reduction in melt (crucible furnace). Characterization by x-ray, quantitative oxidation, volatilization as WO₂Cl₂ (vac system).

*INORG ANAL IONX REDOX UVIS 2 3

Ion Exchange Separation of the Oxidation States of Vanadium

Cornelius, R.

J. Chem. Educ. 57,316 (1980)

(VO₃⁻) ion used as starting material to produce (VO₂⁺), (VO²⁺), (V³⁺), (V²⁺) species which are separated using ion exchange resin AG50W-X2. Reducing agents are hot conc. HCl, mossy Zn and dilute potassium permanganate. UV is optional. Distinct colors, students deduce oxidation states. 3 hr. Nice.

*INORG ACBA DEMO GAS 1

Acid-Base Reactions in the Gaseous State

Corso, C. R.; DeOliveira, J. E.

J. Chem. Educ. 55,244 (1978)

HCl and ammonia. Simple apparatus.

*INORG COORD EDTA KEQ NMR 5

Temperature Dependent Magnetic Measurements and Structural Equilibria in Solution

Crawford, T. H.; Swanson, J.

J. Chem. Educ. 48,382 (1971)

Research report. Mag. moment and equilibrium data for certain acetyl-acetone, salicyl, and EDTA complexes of first row transition elements at varying temperatures. Variable temp. probe. See also Deutsch, J.L.; Poling, S.M., J. Chem. Educ. 46, 167(1969).

*INORG ANAL APPARATUS COORD KIN PREP UVIS 3 HAZARD

An Introductory Chemistry Synthesis and Kinetics Experiment

Crumbless, A. L.

J. Chem. Educ. 53,528 (1976)

Prep'n and characterization of (Co(NH₃)₅N₃)Cl₂; rate of its reduction by iron(II) followed colorimetrically. HAZARD: azides are storage and disposal hazards (explosion, toxicity).

*INORG PREP REDOX 2 HAZARD

The Chemistry Involved in the Preparation of a Paint Pigment: An experiment for the Freshman Laboratory

Daines, T. L.; Morse, K. W.

J. Chem. Educ. 53,117 (1976)

Prepn of PbCrO₄ from chromium(III) nitrate. Explicit details. HAZARD: Chromium(VI) compounds are carcinogenic.

*INORG ANAL COORD DTA HITEMP PREP 3

Thermal Decomposition of Potassium Bisoxalatocuprate (II) Dihydrate:
An Inorganic Analytical Experiment.

Darley, J. R.; Hoppe, J. I.

J. Chem. Educ. 49,365 (1972)

Preparation, thermal decomposition (muffle furnace, 500 deg. C.)

and analysis of pure salt and decomposition products by a variety

of techniques; eg. edta titration, gravimetry

*INORG ANAL AA-FP IONX 3

Hydrolysis of a Chromium(III) Complex Using Atomic Absorption and Ion
Exchange

Davies, M. B.; Lethbridge, J. W.

J. Chem. Educ. 50,793 (1973)

Hydrolysis of oxalato-bis(ethylenediamine)chromium(III)bromide, sepn on
cation exchanger, atomic absorption analysis. Two 3 hr. lab periods.

*INORG ANAL PREP REDOX TITN 3

Oxidation States of Vanadium

Davis, J. M.

J. Chem. Educ. 45,473 (1968)

A modification of the experiment in which various oxidation states of
vanadium are produced and analyzed. Reduction of ammonium vanadate;
MnO₄⁻ titration. Somewhat confusing.

*INORG COURSE DEMO 1 2

Popper's Epistemology as a Pedagogic and Didactic Principle, or: Let Them
Make More "Mistakes"

Derkse, W.

J. Chem. Educ. 58,565 (1981)

Some simple experiments in which student expectations and the results of
the experiments are quite different are described. How to get away from
"cookbook" labs; this is one way students learn.

*INORG ANAL PREP STOICH 2

The Stoichiometry of Copper Sulfide Formed in an Introductory Laboratory
Exercise

Dingledy, D.; Barnard, W. M.

J. Chem. Educ. 44,242 (1967)

The use of Cu₂S synthesis to demonstrate law of constant proportions
is poor pedagogy because, at temperatures used, composition is variable
due to formation of solid solutions of Cu₉S₅ in Cu₂S.

*INORG ELECTROCHEM NOPROC REDOX 2

Anodizing Aluminum with Frills

Doeltz, A. E.; Tharaud, S.; Sheehan, W. F.

J. Chem. Educ. 60,156 (1983)

Elaboration and extensions of Blatt,R.G., J. Chem. Educ. 56,268 (1979)
(procedure given in a separate publication). Compare solubility rates
of Al and Al₂O₃ in acid and base. Simple homemade circuit described.

*INORG PHYS DEMO THERMO 2

A Demonstration of Burning Magnesium and Dry Ice.

Driscoll, J. A.

J. Chem. Educ. 55,450 (1978)

Thermodynamics predicts that magnesium metal should react with CO₂
(enthalpy negative). Reaction goes spectacularly. Product is a black
mass of charcoal in a white crust of MgO. Caution: Protect eyes
against intense light and possible hot particles. A tested demonstration.

*INORG DEMO ENVIRON UVIS 2 HAZARD

Ultraviolet Absorption of Ozone

Driscoll, J. A.

J. Chem. Educ. 54,675 (1977)

Reports successful use of an ozone generator and UV light source to
demonstrate that ozone will absorb ultraviolet light whereas O₂ will
not. HAZARDS: Electric discharge, UV and ozone.

*INORG ANAL ASPIRIN COORD EDTA ELECTROCHEM PREP PROJ UVIS 2

A Copper (II) Aspirinate Project for the General Chemistry Laboratory.

Dudek, E.

J. Chem. Educ. 54,329 (1977)

Synthesis of the compound and its analysis by various methods (electro-
deposition, EDTA titration, and colorimetry with ethylenediamine, etc.)
Method of continuous variation shows two possible complexes.
Outline only.

*INORG COURSE PREP PROJ 4 HAZARD

Inorganic Reaction Chemistry: A course combining practical work with
book work

Dudeney, A. W. L.

J. Chem. Educ. 48,376 (1971)

Outline of a course to teach inorganic reactions, not in the United States.
HAZARD: many of the reagents are carcinogens or suspected carcinogens.
Especially dangerous are the Be++ salts, which should never be issued to
undergraduate students.

***INORG DEMO EXPLOSION KIN REDOX 1 HAZARD**

Spontaneous Combustion: Acetylene

Dunbar, R. E.

J. Chem. Educ. 35 ,A29 (1958)

A Chem-Ed Tested Demo. Calcium carbide, sodium hypochlorite, HCl.

HAZARD: explosive hazard.

***INORG ANAL COORD PREP UVIS 3 HAZARD**

Spectra of Cr(III) Complexes: An Inorganic Chemistry Experiment.

Dunne, T. G.

J. Chem. Educ. 44 ,101 (1967)

Ethylenediamine; 2,4-pentanedione. Crystal field splitting. Recording spectrophotometer.

HAZARD (avoidable): Benzene - carcinogen.

***INORG COORD MAGNETIC UVIS 3**

Magnetic Moment Measurement of a Coordination Complex

Dunne, T. G.

J. Chem. Educ. 44 ,142 (1967)

Prep'n (by ref.) of $K_3Fe(C_2O_4)_3 \cdot 3H_2O$; mag. suscept. by direct measure (magnet. Gaussmeter) or by calibration with $HgCo(CNS)_4$. Visible spectrum.

***INORG ANAL ACBA DEMO ELECTROANAL 1**

The Removal of Ions by Metathesis Reactions

Dutton, F. B.

J. Chem. Educ. 35 ,A53 (1958)

Titration of $Ba(OH)_2$ with H_2SO_4 followed with a simple conductivity apparatus (40-watt lamp with electrodes). A Chem-Ed Tested Demo.

***INORG DEMO REDOX 1 2 HAZARD**

Oxidation of Bromide and Iodide Ions

Dutton, F. B.

J. Chem. Educ. 40 ,A24 (1963)

Simple redox reactions show as color changes in CCl_4 (HAZARD: carcinogen, substitute less hazardous methylene chloride).

***INORG DEMO REDOX 2**

Oxidation States of Transitional Elements - Vanadium

Dutton, F. B.

J. Chem. Educ. 36 ,A41 (1959)

In situ reduction of vanadate by zinc amalgam. A Chem-Ed Tested Demo.

***INORG COORD UVIS 3**

Allowed and Forbidden d-d Transitions in Tris-oxalato-Cr(III) Anion

Eaton, S. S.; Yager, T. D.; Eaton, G. R.

J. Chem. Educ. 56 ,635 (1979)

Preparation of the potassium salt by reference. Visible spectroscopy in aq. sol'n gives wavelength of allowed and forbidden bands, permitting calculation of ligand field strength.

***INORG GAS PREP 2 HAZARD**

A Temperature-Sensitive Stirring Rod: Liquefaction of NO_2 as a student experiment

Eddy, R. D.; Scholes, S. R., Jr.

J. Chem. Educ. 35 ,527 (1958)

A small amount of nitrogen dioxide and its equilibrium dimer prepared and sealed in a small glass tube. A charming experiment, but (HAZARD) nitrogen oxides are toxic.

***INORG APPARATUS DEMO IONX WATERCHEM 2**

Hard Water, Water Softening, Ion Exchange

Egen, N.; Ford, P. C.

J. Chem. Educ. 53 ,302 (1976)

Simple apparatus (constr. details given) for prep. of deionized tap water using ion exchange resin, plus simple tests (sudsing, elec. cond.) for hardness. A tested demonstration.

***INORG DRYLAB ISOTOPE NOPROC 2**

Isotopy, A General Chemistry Experiment

Ehlert, T. C.

J. Chem. Educ. 48 ,273 (1971)

Recorded mass spectra of elements used to identify elements.

***INORG COORD NMR PHOTO PREP PROJ UVIS 5**

Synthesis, Characterization, and Photogeneration of

2-Methylpyrazinepentacyanoiron(II) Complex

Ernhoffer, R.; Kovacs, D.; Subak, E., Jr.; Shepherd, R. E.

J. Chem. Educ. 55 ,610 (1978)

Starting materials: $Na_2(Fe(CN)_5NO) \cdot 2H_2O$ and 2-methylpyrazine. Compound in title prepared (1) by thermal synthesis, and (2) photochemically and characterized uvis, nmr.

***INORG ANAL GAS PREP 2**

The Titration of Air with Nitric Oxide: An Application of Gay-Lussac's Law of Combining Volumes in a General Chemistry Experiment
Everett, K. G.

J. Chem. Educ. 59,802 (1982)

Prep. of nitric oxide and oxygen by thistle tube methods. They are then reacted in a 100-ml graduated cylinder inverted in a pneumatic trough to demonstrate Gay-Lussac's Law. The oxygen content of a wet air sample is found by adding successive 5-ml portions of NO and plotting volume of mixture vs. total volume added NO.

***INORG ANAL PHYS ACBA COORD ELECTROANAL PREP PROJ UVIS 3**

Physical and Chemical Properties of the Copper-Alanine System:
An Advanced Laboratory Project

Farrell, J. J.

J. Chem. Educ. 54,445 (1977)

Intended for biology majors course in "Physical Chemistry of the Life Sciences". Project includes titration, determination of equilibrium constants, use of the spectrophotometer, etc. Minimal directions. Within capacity of many freshman.

***INORG REDOX 1 2**

Studying the Chemical Properties of Metallic Aluminum

Feifer, N.

J. Chem. Educ. 45,648 (1968)

Aluminum amalgam reacts water, aq. metal salts in test tube redox reactions.

***INORG COORD UVIS 4**

Electronic Transitions as a Probe of Tetrahedral Versus Octahedral

Coordination in Nickel(II) Complexes: An undergrad. inorganic chem. exp't

Filgueiras, C. A.; Carazza, F.

J. Chem. Educ. 57,826 (1980)

Metal ion complexes with different symmetries are prepared, and their electronic spectra used to illustrate aspects of ligand field theory. Clear discussion of results and conclusion.

***INORG DEMO NOPROC PROJ 2 3 HAZARD**

The Ammonium Dichromate Volcano as an Introductory Laboratory Project
Finholt, J. E.

J. Chem. Educ. 47,533 (1970)

The usual demo translated into a project to analyze reaction or products.

HAZARD: chromium(VI) compounds are carcinogens. Unless care and hood are used, some dichromate gets into the air.

***INORG COORD GEOM KIN UVIS 2**

Isomerism in Transition Metal Complexes: An experiment for freshman chemistry laboratory

Foust, R. D., Jr.; Ford, P. C.

J. Chem. Educ. 47,165 (1970)

Cobalt(III) ethylenediamine complexes. Prep'n of the green cis- and purple trans-. Rates of isomerization followed spectrophotometrically.

***INORG ANAL PHYS COMPLEX NMR STOICH TITN 4**

A Proton Magnetic Resonance Coordination Number Study: $AlCl_3$ in Aqueous Solvent Mixtures

Fratiello, A.; Schuster, R. E.

J. Chem. Educ. 45,91 (1968)

Nmr variable temp. probe (-20 deg.) to determine bound and free water.

Requires accurate chloride (titr) det'n.

***INORG DEMO ELECTROCHEM MOLTENSALT PREP 2 HAZARD**

Preparation of Metallic Lithium

Geffner, S. L.

J. Chem. Educ. 38,441 (1961)

Electrolysis of molten $LiCl$. HAZARDS: 1) $LiCl$ is somewhat toxic. 2) While the theory of this experiment is easily within the grasp of the students at level 2 (or 1), the technique is not. Specifically, there are high temp. hazards, such as "spitting" if the $LiCl$ is not completely anhydrous, and there are also electrical hazards. A Chem-Ed Tested Demo.

***INORG COMPLEX DEMO ELECTROCHEM 2**

Silver Plating From an Iodide Complex

Geffner, S. L.

J. Chem. Educ. 38,441 (1961)

$AgNO_3/KI$ solution. The plate is said to be excellent; it may be buffed to a high luster. A Chem-Ed Tested Demo.

***INORG PHYS DEMO LUMIN PREP 3 HAZARD**

Triboluminescence of New Uranyl Salts

Gil, J. M.; Gil, F. J. M.

J. Chem. Educ. 55,340 (1978)

Assorted double salts of Be, Sr, Ba, Ni, etc. and uranyl (acetate, sulfate, oxalate), prepn mostly by reference, are triboluminescent. This article discusses 3 alternative excitation mechanisms. TL is excited by crushing crystals in the dark or by thermal shock. Little detail.

***INORG DEMO HITEMP 1**

Thermal Decomposition of Water by the Use of the Nernst Glower

Glaser, J. O.

J. Chem. Educ. 46 ,A49 (1969)

Nernst glower is a way to reach 2300 C. A Chem Ed Tested Demonstration.

***INORG COMPLEX PREP SEQ 3 4**

An Experiment Involving the Chemistry of Systems Containing Metal-Metal Double, Triple and Quadruple Bonds

Glicksman, H. D.; Walton, R. A.

J. Chem. Educ. 54 ,712 (1977)

Six rhenium complexes in sequence, beginning with perrhenate. Some by literature ref. Extensions suggested.

***INORG HETEROCYCLIC HISTORIC IR MASSPEC NMR PROOF VACTEK 4 HAZARD**

Reactions of Thiocyanate Ions with Acid

A Laboratory Experiment

Glidewell, C.; McKechnie, J. S.; Pogorzelec, P. J.

J. Chem. Educ. 61 ,78 (1984)

The experiment involves the identification of products from the reaction of 1) solid KNCS with H₂SO₄, 2) aq. KNCS with H₂SO₄, and 3) zanthan hydride (from 2) with H₂SO₄. Mass spectral data and C-13 and N-15 nmr data are provided. Directions are in style for advanced work; some material should be discussed with students after their work. HAZARDS: HCN and OCS

***INORG COORD NMR PREP UVIS 4**

Synthesis, Characterization, and Use of a Cobalt(II) Complex as an NMR

Shift Reagent: An integrated laboratory experiment

Goff, H. M.; Hines, J.; Griesel, J.; Mossman, C.

J. Chem. Educ. 59 ,422 (1982)

Straightforward. Detailed procedure for synthesis (not difficult) of the acetylacetonate of Co(II), analysis for Co (spectrophotometric) and suggestions for NMR shift reagent work.

***INORG CLATH COMPLEX CRYSTAL PREP 2**

A Simple Host Lattice Experiment

Graddon, D. P.

J. Chem. Educ. 47 ,711 (1970)

Isothiocyanate complexes with pyridines. Prepn of M(NCS)₂·py₄, M = Co⁺⁺, Zn⁺⁺, Cu⁺⁺. In cocrystallization of Zn⁺⁺ and Cu⁺⁺ compound, the Zn(NCS)₂(py)₂ traps and stabilizes tetrahedral Cu(NCS)₂(py)₂.

***INORG ANAL REDOX 1**

Vanadium for High School Students

Grant, A. W., Jr.

J. Chem. Educ. 54 ,500 (1977)

Emphasis is on color of lower oxidation states produced by zinc reduction of vanadium(V). Students are to titrate violet V(II) back to yellow V(V) with permanganate, noting colors of V(III) and V(IV).

***INORG ANAL COORD DEMO KEQ 2**

Cobalt Complexes and Le Chatelier

Grant, A. W., Jr.

J. Chem. Educ. 61 ,466 (1984)

A demo. or expt. involving Co(H₂O)₆²⁺/CoCl₄²⁻ equilibrium and color change. Addition of Cl⁻ from other than HCl does not cause color change, since dehydration by strong acid is more important than Cl⁻ concentration. Corrects earlier interpretation.

***INORG ANAL COORD SEQ 2**

Cobalt(III) Ammines - "Werner" Complexes: An Undergraduate Experiment

Greenaway, A. M.; Lancashire, R. J.

J. Chem. Educ. 59 ,419 (1982)

Reaction sequence, starting with cobalt(II) sulfate, through the carbonato-tetraammine compound to the cis-diaquotetraammine salt to the interesting tetranuclear species which Werner resolved. More than one lab period. Typo: compound I is a bromide rather than a boride.

***INORG COORD MAGNETIC PREP 4 HAZARD**

Magnetic Susceptibility: A Practical Introduction

Greenaway, A. M.; Trail, L. E.

J. Chem. Educ. 60 ,681 (1983)

Prepn of tris(acetylacetonato)iron(III), tris(diethyldithiocarbamato)iron(III), and chlorobis(diethyldithiocarbamato)iron outlined. Magnetic susceptibility by Guoy method. Interpretation of mag. suscept. data of these compounds and of potassium ferricyanide discussed. HAZARD: benzene is mentioned, but CHCl₃ is also a carcinogen.

***INORG CONSUMERPROD DEMO ELECTROCHEM REDOX SURFACE 2**

Dyeing of Anodized Aluminum

Grotz, L. C.

J. Chem. Educ. 60 ,763 (1983)

Tested Demonstration. Uses Congo Red dye. Similar to J. Chem. Ed. 56,268 (1979) and 60,156 (1983).

***INORG APPARATUS HPRESS ORGANOMETAL PREP 4 HAZARD**

High Pressure Synthesis of Transition Metal Carbonyls

Hagen, A. P.; Miller, T. S.; Terrell, D. L.; Hutchinson, B.; Hance, R. Daniels, L.

J. Chem. Educ. 56,479 (1979)

Tungsten and molybdenum hexacarbonyls by direct reaction of trioxides with CO at 350 deg. at 1000 atm. Details for microreactor given.

HAZARD: Toxicity, high pressure.

***INORG ANAL ACBA COORD DTA MAGNETIC NOPROC PREP PROJ 2**

Experiments on Metal Ammine Salts

Haight, G. P., Jr.

J. Chem. Educ. 42,468 (1965)

(Cu(NH₃)₄H₂O)₂SO₄ prepared and investigated by a variety of methods: iodimetry (Cu), precipitation (SO₄=), thermal decomposition, etc. Extensions to other metal ammine salts.

***INORG DEMO MAGIC 0**

Chemistry is Fun, Not Magic

Hanson, R. H.

J. Chem. Educ. 53,577 (1976)

Experiments to entertain and illustrate very simple principles for elementary students; mostly taken from other sources, but well-integrated.

***INORG COORD GEOM IR PREP UVIS 4**

An Experiment on Isomerism in Metal-Amino Acid Complexes: Prep. and Char. of Cobalt(III) Complexes Containing N-Bonded Monodentate, etc.

Harrison, R. G.; Nolan, K. B.

J. Chem. Educ. 59,1054(1982)

Detailed procedure for syntheses; spectrophotometric and potentiometric analyses allow student to distinguish product given 3 candidates. Type: candidate species are printed inverted. Caution: perchlorates are a storage hazard; cobalt complexes may explode on heating.

***INORG ANAL STOICH 1**

Determining an Empirical Formula: A simple, rapid high school experiment

Harris, S. P.

J. Chem. Educ. 37,516 (1960)

Copper wire heated in sulfur vapor and weight changes measured on simply constructed balance. CAUTION: Adequate ventilation required.

***INORG COORD GEOM UVIS 3 HAZARD**

Spectral Comparison of Geometric Isomers

Haworth, D. T.; Elsen, K. M.

J. Chem. Educ. 50,300 (1973)

Cis and trans isomeric ethylenediamine, oxalate, etc., complexes of Co(III) and Cr(III) prepared, and uvis spectra measured. HAZARD: chromium(VI) starting material is carcinogen.

***INORG ANAL FLUOR QUAL 2**

A Fluorescent Indicator for a Confirmatory Test for the Aluminum Ion

Haworth, D. T.; Starshak, R. J.; Surak, J. G.

J. Chem. Educ. 41,436 (1964)

PAN(1-(2-pyridylazo)-2-naphthol) gives distinct color and uv-stimulated fluorescence.

***INORG ANAL KSP NONAQ NOPROC PREP SOLUB 2 3**

Student Experiments Involving Unknown Solubility Constants

Heinz, D. E.

J. Chem. Educ. 44,114 (1967)

Students are provided with either sorbic or cinnamic acid, asked to synthesize, purify and identify one of Ag⁺, Cu⁺⁺, Pb⁺⁺ or Zn⁺⁺ salt and detn Ksp in a mixed solvent. Almost no detail.

***INORG PREP PROJ SEQ TITN 3 HAZARD**

Synthesis, Properties, and Hydrolysis of Antimony Trichloride

Hentz, F. C., Jr.; Long, G. G.

J. Chem. Educ. 52,189 (1975)

Reaction of Sb₂O₃ with HCl, followed by distillation. Hydrolysis products are analyzed by acid-base and by KMnO₄ titration. Hazards: SbCl₃ evolves HCl on contact with water, and is toxic and burns skin. All antimony-containing compounds are somewhat toxic.

***INORG PHYS COORD KIN PREP REDOX UVIS 3 HAZARD**

The Preparation and Kinetics of Aquation of Bromopentaquo chromium(III): A new multipurpose experiment

Herman, I. J.; Lifshitz, A.

J. Chem. Educ. 47,231 (1970)

CrO₃ is reduced (by H₂O₂) to Cr(II), then oxidized by Br₂ to the compound. Rate of hydrolysis at two temp. by uvis. HAZARDS: Cr(VI) is a carcinogen; bromine (burns).

*INORG PHYS REDOX 2

A Copper Mirror: Electroless Plating of Copper

Hill, J. W.; Foss, D. L.; Scott, L. W.

J. Chem. Educ. 56, 752 (1979)

Simple experiment for basic techniques and theory in Gen. Chem. Lab. Cu self-plates from tartrate soln onto a prepared glass surface. Technique is critical. Remark: "electroless" means an electrochemical reduction carried out without the use of a current source.

*INORG PHYS COORD EXCHANGE KEQ KIN UVIS 4

A Method for the Determination of Stability Constants of Unstable Complexes

Hin-Fat, L.; Lee, H-C.

J. Chem. Educ. 61, 925 (1984)

Kinetic method for determining the stability constant of $\text{Co}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2$ by measuring the rates of its complex decomposition in acidic buffers which are also ligands. Prepn. of starting material by reference.

*INORG COORD IR ISOMERS KIN PREP PROJ SOLID 3

A Combined Infrared and Kinetic Study of Linkage Isomers: An inorganic experiment

Hohman, W. H.

J. Chem. Educ. 51, 553 (1974)

Nitro- and nitropentamminecobalt(III) chloride synthesized (easy).

IR (KBr pellet). Kinetics of interconversion in solid state by ir (weeks). Extensions.

*INORG ANAL PHYS COMPLEX IR NOPROC STOICH 4

Determination of Hydration Numbers by Near Infrared: An advanced undergraduate experiment

Hollenberg, J. L.

J. Chem. Educ. 56, 278 (1979)

An alternative to Kahn and Stephens' method (for abstract, see this document), avoiding the addition of the inert salt. The mthd is based on differential near-IR spectra of the aq. solutions, compared to pure water. Not detailed experimentally, but theory explicit. See Jayne, J., J. Chem. Educ. 59, 883 (1982) for an important modification of assumptions.

*INORG IR MASSPEC PHOTO PREP VACTEK 5

The Photochemical Reaction of Xenon with Fluorine at Room Temperature: A demonstration of the reactivity of xenon

Holloway, J. H.

J. Chem. Educ. 43, 202 (1966)

Not a class demo. Pure xenon and pure fluorine mixed in evacuated bulb (precautions on dry, pure) in sunlight form crystals of XeF_2 , examine ir (KBr) and mass spec.

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*INORG CHIRAL GEOM ISOMERS POLARIM PREP RESOLUTION 4

The Resolution of a Racemic Compound: An experiment for the inorganic laboratory

House, D. A.

J. Chem. Educ. 53, 124 (1976)

Resolution of $\text{cis}-(\text{CoCl}(\text{en})_2(\text{MeNH}_2))^{++}$ using potassium (+)-tartrato-(-2)antimony(III) oxide. The (+) cation is isolated as the tetrachlorozincate by the addition of the less soluble diastereomer. For isolation of the (-) cation, use is made of differences between the racemic and the (-) dithionates.

*INORG IR MAGNETIC ORGANOMETAL PREP PROJ 4 HAZARD

The Design of Integrated Inorganic Experiments: An example from organo-transition element chemistry

Hunt, G. R. A.

J. Chem. Educ. 53, 53 (1976)

Cyclopentadienyliron dicarbonyl dimer prepared iron pentacarbonyl and dicyclopentadiene, reduced. Det'n magnetic, infrared, pmr(variable temp). Lit., extensions. Ir - detailed discussion. For prep: refer literature.

HAZARD: metal carbonyls extremely toxic.

*INORG COORD POLARIM PREP RESOLUTION 2 3

Synthesis and Properties of an Optically Active Complex: A polarimeter experiment for general chemistry

Hunt, H. R., Jr.

J. Chem. Educ. 54, 710 (1977)

Cobalt(II)-phenanthroline complex resolved by pptn. as antimony d-tartrate salt, then oxidized by chlorine (from $\text{HCl} + \text{KMnO}_4$) to cobalt(III) complex. Extensions.

*INORG PROJ 1 2

The Growth of Lead Trees in Silicic Acid Gels

Hurd, C. B.; Lamareaux, H. F.

J. Chem. Educ. 36, 472 (1959)

Lead nitrate, dilute acetic acid and sodium silicate gel in test tube.

Zinc metal to form tree. Extensions, refs. to earlier J. CHEM. EDUC. (1929-1935).

*INORG COORD IR PREP 4 HAZARD

A Non-Hazardous, Bench Top Experiment With an Electron-Deficient Compound

James, B. D.

J. Chem. Educ. 52, 260 (1975)

Bis(triphenylphosphine)copper(I) tetrahydroborate prepared and ir spectrum discussed, also thermal decomp. Warning: non-vacuum technique - triphenyl phosphine evolved during thermal decomp. HAZARD: benzene, carcinogen.

*INORG COORD PREP 3

The Busy Student's Guide to The Nitration of Tris-Acetylacetonates of Cobalt(III) and Chromium(III)

James, B. D.

J. Chem. Educ. 51,568 (1974)

Half of a lab period suffices for copper nitrate-acetic anhydride nitration of metal acetylacetonates, such as cobalt.

*INORG ORGANOMETAL PREP 4 HAZARD

Ferricinium Picrate: Preparation of a ferrocene derivative

Johnson, D. W.; Rayner-Canham, G. W.

J. Chem. Educ. 49,211 (1972)

Ferricinium ion is prepared by reacting ferrocene with benzophenone; picric acid ppts the salt. IR, VIS, NMR and MASSPEC parameters discussed. Hazard: picrates (explosive).

*INORG PREP 2

A Convenient Procedure For The Preparation of Potassium Trioxalatoferrate(III)

Johnson, R. C.

J. Chem. Educ. 47,702 (1970)

Easy (less than one period) prep'n. No characterization, but suggestions.

*INORG DEMO PREP 2

The Preparation of Various Kind of Glass

Jones, R. F.

J. Chem. Educ. 55,450 (1978)

Boron and silicon glasses are prepared using Meeker burner or gas-oxygen hand torch. May be colored with cobalt. A tested demonstration.

*INORG IONX NMR STOICH 4

Determination of Hydration Number by NMR: An advanced undergraduate experiment

Kahn, E. M.; Stephens, J. F.

J. Chem. Educ. 54,62 (1977)

Variable temp. probe required. Some standardization by ionx and titn.

Addition of $\text{Ca}(\text{NO}_3)_2$ to solutions of Al, Ca, Ga, In salts allows low temp.

(-35 deg.C) resolution of protons in hydration shell and rough integration. Caution: watch out for freezing tubes in the probe.

*INORG ACBA PREP STOICH UVIS 2 HAZARD

The Stoichiometry of Silver Chromate and Basic Copper Chromate

Kalbus, L. H.; Petrucci, R. H.

J. Chem. Educ. 46,776 (1969)

Silver chromate by continuous variation method (ref.). Copper chromate prep'n given, characterization by acid titration and spectrophotometry at 610 and 440 nm. HAZARD: chromates are carcinogenic.

*INORG ANAL ACBA COORD TITN 3

The Preparation and Analysis of Some Metal-Pyridine Complexes: A general chemistry experiment

Kauffman, G. B.; Albers, R. A.; Harlan, F. L.

J. Chem. Educ. 50,70 (1973)

M(II) pyridine-thiocyanate complexes, M(II) is Mn, Fe, Ni, Cu, Zn. Simple analysis. Extensions optional (ref).

*INORG HISTORIC IONX PREP 2

Wohler's Syntheses of Artificial Urea: A modern version of a classic experiment

Kauffman, G. B.; Chooljian, S. H.

J. Chem. Educ. 56,197 (1979)

Ammonium cyanate from silver or lead cyanate (Wohler method) or by ion exchange, or metathesis. Formation of urea is confirmed by acid and base reactions, heavy metal salts.

*INORG COORD PREP QUAL REDOX 2 HAZARD

Pseudohalogens: A general chemistry laboratory experiment

Kauffman, G. B.; Foust, G. E.; Tun, P.

J. Chem. Educ. 45,141 (1968)

Prep'n of many compounds by test tube reactions, analysis, redox properties. Many reactions. HAZARDS: cyanides, thiocyanogen, cyanogen, bromine and references to other hazardous preparations. Bibliographers suggest too hazardous for gen. chem. students. Moreover, the hazards are not limited to the lab period, but extend to disposal, storage, etc.

*INORG ANAL NOPROC PREP TITN 2

Syntheses and Titrations of Unknown Acids

Kauffman, G. B.; Houghten, R. A., Jr.

J. Chem. Educ. 44,408 (1967)

Suggestions for preparation (by ref.) and analysis by acid-base titration of seven inorganic and organic acids.

*INORG COMPLEX CRYSTAL ELECTROPHOR HISTORIC PREP REVIEW 4 HAZARD INORG ACBA PREP STOICH 2 HAZARD

Metallo Complexes: An Experiment for the Undergraduate Laboratory
Kauffman, G. B.; Karbassi, M.; Bergerhoff, G.

J. Chem. Educ. 61, 729 (1984)

A thorough review of metallo complexes (complex ion with non-metal center surrounded by metal atoms); over 100 references. Prepn. of 9 different complexes detailed. Extensions possible. HAZARDS clearly noted involve use of beryllium and mercury compounds, KCN and CS₂.

*INORG CHIRAL COORD GEOM HISTORIC ISOMERS PROOF RESOLUTION 4

A Classic in Coordination Chemistry: A resolution experiment for the inorganic laboratory

Kauffman, G. B.; Lindley, E. V., Jr.

J. Chem. Educ. 51, 424 (1974)

Follows Werner's proof of octahedral configuration of cis-bromoamminebis-(ethylenediamine)cobalt(III) bromide (prep. ref.). Reaction with ammonium(+)-alpha-bromocamphor-pi-sulfonate gives diastereomers, separable by crystallization. Polarimetry.

*INORG CHIRAL COORD ISOMERS PROJ RESOLUTION 4

Resolving Coordination Compounds by a Second Order Asymmetric Synthesis

Kauffman, G. B.; Sugisaka, N.; Reid, I. K.

J. Chem. Educ. 41, 461 (1964)

D-Oxalatobis(ethylenediamine)cobalt(III) iodide used to resolve trisoxalatochromate(III) ion. Preparations of both by reference. Extensions to racemization rates. Polarimeter.

*INORG PHYS CHIRAL COORD KIN POLARIM RESOLUTION 4

Resolving Optically Active Coordination Compounds: An experiment for the inorganic laboratory

Kauffman, G. B.; Takahashi, L. T.

J. Chem. Educ. 39, 481 (1962)

Trisoxalatocobaltate(III), tris(1,10-phenanthroline)nickel(II) resolved with potassium d-antimony tartrate. Cold solutions, rapid work-up, seems not simple. Racemization rates followed.

*INORG COORD TECHNIQUE 3

The Lighter Lanthanides: A laboratory experiment in rare earth chemistry

Kauffman, G. B.; Takahashi, L. T.; Vickery, R. C.

J. Chem. Educ. 40, 433 (1963)

Fract. crystallization, sep'n and identification of Ce, La, Pr, Nd. Uses Lindsay code 330 rare earth oxide. Simplified procedures, but refs.

Isopoly and Heteropoly Compounds: A general chemistry laboratory experiment

Kauffman, G. B.; Vartanian, P. F.

J. Chem. Educ. 47, 212 (1970)

Molybdates, phosphomolybdates, tungstocobaltates, etc. prepared.

Characterization by titr., conductance (not quant.), redox, precipitation, ionx, etc. Extensions. HAZARD: some preparation use chromates and arsenates - carcinogenic and toxic.

*INORG ORG GC MASSPEC PREP 4 HAZARD

The Preparation of Anhydrous Chromium(III) Chloride and the Pyrolysis of Carbon Tetrachloride.

Keiter, R.; Ahnger, T.; Maurice, A.; Baldwin, T.

J. Chem. Educ. 55, 52 (1978)

Reports identification of the white solid which may form together with CrCl₃ in student prep of this compound from chromium(III) oxide and carbon tetrachloride at 800 deg. as a mixture, principal components hexachloroethane and hexachlorobenzene. Also reports successful classroom use of this identification by mass spec and gas chromatography as a student project. Hazard: carcinogens.

*INORG PHOTO SOLID 2

A Short Experiment in Xerography

Keyzer, H.

J. Chem. Educ. 46, 530 (1969)

Sulfur layer activated by electrostatic charge (rub with fur), then image of opaque object developed by UV.

*INORG PHYS COORD QUANTUM UVIS 5

D(8) Energy Level Diagram: An experiment for advanced students

Kilner, M.; Smith, J. M.

J. Chem. Educ. 45, 94 (1968)

Nickel complexes (supplied) used for 300-1000 nm spectrum.

Study questions.

*INORG ANAL AA-FP IR 2 3

The Chemistry of Seashells

Kinard, W. F.

J. Chem. Educ. 57, 783 (1980)

IR provides low-cost intro to crystal structure when X-ray isn't available. Site symmetry of CO₃ in aragonite and calcite creates difference in vibrational spectra. Mulls okay for qual.; pellets give accuracy comparable to X-ray. Mg content determined by AA.

*INORG ANAL COORD EDTA PREP TITN 3

Preparation and Properties of a Series of Cobalt(II) Complexes

King, H. C. A.

J. Chem. Educ. 48,482 (1971)

Pyridine complexes. EDTA titration.

*INORG ELECTROANAL NOPROC STOICH 2

Experimental Approach to Stoichiometry

King, L. C.; Cooper, M.

J. Chem. Educ. 42,464 (1965)

Students given minimal directions, to approach as a research problem - solubility, acid-base tit'n, coordination, mostly using pH meter.

*INORG CRYO KEQ 2

Demonstration of a Reaction in Frozen Aqueous Solutions

Kiovsky, T. E.; Pincock, R. E.

J. Chem. Educ. 43,361 (1966)

Equilibrium in the arsenic acid-iodine reaction is affected by concentration (responsive to freezing), gives color change.

*INORG ANAL ACBA HISTORIC PREP TITN 2

The Solvay Synthesis of Sodium Hydrogen Carbonate

Kirksey, H. G.

J. Chem. Educ. 55,272 (1978)

Drop dry ice into sodium hydroxide and immediately cap with a large sturdy balloon. Students are not given a procedure, are asked to prepare, and prove they prepared the product. Requires discussion and experimentation. This is for the instructor.

*INORG STOICH 2

The Oxidation Number of Silicon: An introductory experiment

Kirksey, H. G.

J. Chem. Educ. 51,399 (1974)

Silicon reacted with NaOH, weight loss and volume of hydrogen measured. Caution: hydrogen evolved.

*INORG ORG DEMO ORGANOMETAL PREP 4 HAZARD

Preparation of Ethylaluminum Sesqui-Iodide: a lecture demonstration

Krahe, E.; Rochow, E. G.

J. Chem. Educ. 43,63 (1966)

From ethyl iodide and aluminum. HAZARDS: violently reactive compounds, toxic compounds, iodine vapor.

*INORG PHYS COMPUTER DRYLAB GEOM KIN NMR PROOF 4 5

Nuclear Magnetic Resonance Studies of the Stereochemistry and Non-Rigidity

of Titanium-Beta-Diketonate Complexes: An interpretative NMR experiment

Kranbuehl, D. E.; Metzger, P. M.; Thompson, D. W.; Fay, K. C.

J. Chem. Educ. 54,119 (1977)

Analysis of low temp. proton nmr studies three complexes to predict structure. Computer simulation of nmr. Kinetics and mechanism of ligand rearrangement. Could be all drylab or students could either run nmr (to -50 deg. C) or prepare complexes.

*INORG COORD PREP 2

Student Synthesis of Tris(ethylenediamine)cobalt(III) Chloride

Krause, R. A.; Megargle, E. A.

J. Chem. Educ. 53,667 (1976)

Easy one period preparation by a rapid method. See also Krause, R.A., J. CHEM. EDUC., 55, 453 (1978) and Sharrock, P., J. Chem. Ed., 57, 778 (1980) for additional comment and modifications.

*INORG CRYSTAL DENSITY MAGNETIC PREP SOLID XRAY 4

The Synthesis and Characterization of Some Fluoride Perovskites

An Undergraduate Experiment in Solid State Chemistry

Langley, R. H.; Schmitz, C. K.; Langley, M. B.

J. Chem. Educ. 61,643 (1984)

All preparations are by a similar procedure. Products are characterized by experimental x-ray diff., density, and mag. susceptibility. Little discussion.

*INORG ANAL AA-FP COORD ELECTROPHOR KEQ 3

Thiocyanatochromium(III) Complexes: Separation by Paper Electrophoresis and Estimation of Stability Constants

Larsen, E.; Eriksen, J.

J. Chem. Educ. 52,122 (1975)

Stepwise formation constants for all six Cr(III)-SCN(-)-H₂O mononuclear Werner complexes estimated. Needs electrophoresis chamber with water-cooled support. Atomic absorption for improved accuracy.

*INORG ACBA COLOR DEMO REDOX 2

The Precipitation of Ferrous Hydroxide: A Lecture Demonstration

Lau, O. W.

J. Chem. Educ. 56,474 (1979)

Shows pale green color of iron (II) hydroxide, then orange of iron (III), and deep blue of the "mixed valence" compound.

*INORG CORROSION DEMO ELECTROCHEM 2

Cathodic Protection Using a Photovoltaic Source

Lauren, P. M.

J. Chem. Educ. 55, 319 (1978)

Suitable as project. Iron electrodes, photovoltaic cell, ferroxyl gel indicator shows anode and cathode by pH change. Also can show protection with sacrificial electrode.

*INORG COORD GEOM NMR UVIS 4

Identification of Geometrical Isomers of Cobalt(III)-Iminodiacetate

System: An inorganic laboratory experiment.

Lawrence, G. A.; Rix, C. J.

J. Chem. Educ. 56, 211 (1979)

Two differently colored geometric isomers prep'd by method of Weyh, J. A., J. Chem. Educ., 47, 715 (1970) - see this bibliography. This article concentrates on the analysis and structure, mostly by PMR in D₂O.

*INORG PHYS COORD CRYSTAL KIN RADIOCHEM SOLID TRACER 3 4 HAZARD

An Experiment with Manifold Purposes: The Chemical Reactivity of Crystal Defects upon Crystal Dissolution

Lazzarini, A. F.; Lazzarini, E.

J. Chem. Educ. 60, 519 (1983)

Co-60 irradiation of polycrystalline NaCl develops F centers (trapped electrons). Soln in water yields hydrated electrons (approx. 10⁻⁴M); their reactivity is studied by conversion of hexamminecobalt(III) chloride (Co-60 labeled, prep. by ref.) to Co(II), which forms an organic sol. complex and extracting (pyridine and CHCl₃; HAZARD). Anal. by gamma detector; varying hexamminecobalt(III) conc. allows extrap. to conc. of e⁻(aq) formed.

*INORG NOPROC 2

Writing Chemical Equations: An introductory experiment

LeMay, H. E., Jr.; Kemp, K. C.

J. Chem. Educ. 52, 121 (1975)

Students identify simple unknowns from their reactions and a simple table of names and properties. An "early" experiment.

*INORG PHYS COORD NMR PH 4 HAZARD

An NMR Protonation Study of Metal Diethylenetriaminepentaacetic Acid

Complexes: An integrated senior chemistry experiment

Letkeman, P.

J. Chem. Educ. 56, 348 (1979)

PMR shifts vs. pH used to find protonation sequence in ligand.

Similarly, shifts in Pb-DTPA or Cd-DTPA used to det'n structure.

Extensions. Hazard: Pb and Cd compounds.

*INORG APPARATUS ELECTROCHEM 3

An Illustration of the Absorption of Hydrogen by Metals

Lewis, F. A.

J. Chem. Educ. 34, 601 (1957)

Palladium and platinum electrodes of 48 volts DC show increase in diameter of Pd because hydrogen formed electrolytically is absorbed. Measure pressure of H₂ evolved on heating.

*INORG COMPLEX NMR 4 5

Allyl Palladium Complexes: A simple experiment illustrating fluxional behavior.

Lindley, J.

J. Chem. Educ. 57, 671 (1980)

Di- η -chlorobis(η^3 -propenyl)dipalladium(II) is simple to prepare. Unlike the methallylpalladium(II) chloride/triphenylphosphine system, the allylpalladium(II) chloride/DMSO also avoids CO and thus creates no hood space problem. Spectral changes illustrate structural changes when switching from noncoordinating solvent (CHCl₃) to strongly basic coordinating solvent (DMSO). Caution: CHCl₃, carcinogen.

*INORG COORD DEMO 2 HAZARD

The Reaction of CN⁻ Ions with Ni(EDTA)²⁻ Ions

Littlejohn, D. G.; Fanning, J. C.; Jostansek, E. C.

J. Chem. Educ. 49, A26 (1972)

Slow reaction with striking color changes. HAZARD: cyanides.

*INORG ANAL COORD GRAVIM IONX MAGNETIC PROJ UVIS 2

The Study of a Cobalt Complex - A Laboratory Project

Loehlin, J. H.; Kahl, S. B.; Durlington, J. A.

J. Chem. Educ. 59, 1048 (1982)

Second-semester introductory course (Wellesley). Synthesis followed by qualitative and quantitative analysis of chloropentamminecobalt(III) chloride or hexamminecobalt(III) chloride (prep by reference). Analytical procedures include iodometric, gravimetric, modification of Kjeldahl method, use of Spec-20, ion exchange, etc. Gouy balance expt. is given in detail.

*INORG DRYLAB 1

Mendeleev's Periodic Law: A laboratory exercise

Logan, K. R.

J. Chem. Educ. 53, 647 (1976)

Students given (known and unknown) samples of elements. Task is to decide placement in periodic table by (given) properties.

***INORG ANAL PREP TITN 2**

Isopolyvanadates: Synthesis and Characterization

Long, G. G.; Stanfield, R. L.; Hentz, F. C., Jr.

J. Chem. Educ. 56,195 (1979)

Easy prep. Analysis for ammonium (Kjeldahl), vanadium (permanganate titr.) and water (P2O5 desiccator).

***INORG DEMO 1**

The Reducing Property of Ammonia: A Chem Ed Tested Demonstration

Long, R. H.

J. Chem. Educ. 49, A85 (1972)

Black CuO and white (NH4)2CO3 react together to give red Cu/Cu2O and nitrogen mixture with obvious water evolution.

***INORG PROJ REDOX STOICH 1**

A Simple Oxidation-Reduction Experiment

Ludeman, S. M.; Brandt, J. A.; Zon, G.

J. Chem. Educ. 53,377 (1976)

Copper (as sulfate, aq.), and lead (as acetate, aq.) self deposit on weighed zinc strips; rate of deposition is studied as a class project. Would make a good "early" experiment to teach analytical balance. Rather sketchy.

***INORG ANAL PREP REDOX STOICH 2**

Simplest Formula of Copper Iodide: A Stoichiometry Experiment

MacDonald, D. J.

J. Chem. Educ. 60,147 (1983)

Prepn of the pure compound by reducing a Cu(II) soln with an iodide-thiosulfate mixture. The Cu(II) soln is prepared by dissolving a weighed amount of copper metal in HNO3. Weight data gives stoichiometry. Long drying time; requires two periods. See Sisler, H.H., J. Chem. Ed., 61, 566 (1984) for a critical comment.

***INORG ANAL COLUMNC NOPROC QUAL 2**

Column Chromatographic Analysis of the Metal Ions

Marie, E., Sr.

J. Chem. Educ. 41,436 (1964)

General description only; detailed experiment can be purchased.

***INORG CATAL HISTORIC HITEMP PREP 2 3**

Synthesis of Sulfuric Acid by the Contact Process: A student laboratory experiment

Martin, J. A.; Baudot, P.; Monal, J. L.; Lejaille, M. F.

J. Chem. Educ. 52,188 (1975)

Special apparatus. Vanadium oxide on silica catalyst in gas train tube furnace (500 deg. C). Warning: SO3 bottle; furnace; exothermic rxn.

***INORG ANAL PHYS ELECTROANAL 3 4**

A Study of the Kinetics of the Substitution Reactions of Square Planar Platinum(II) Complexes as Monitored by Conductance Measurements.

Marzik, J. V.; Sabatelli, A. D.; Fitzgerald, P. F.; Sarneski, J. E.

J. Chem. Educ. 58,589 (1981)

6-8 hrs., or one lab period if Pt(bipy)Cl2 is provided. Kinetics of ligand substitution. Not as expensive as might be thought because of small quantities. Good exposure to small-scale synthesis. Monitored by conductance. Extensions suggested.

***INORG NOPROC PAPER PROJ THERMO UVIS 3 4**

The Polyhalide Experiment and the Open University Summer School

Mason, J.

J. Chem. Educ. 52,244 (1975)

A polyhalide such as KICl2 is given as unknown. Preliminary experiments with halogens, halides, interhalogens. Open ended.

***INORG GRAVIM STOICH 2 HAZARD**

Reduction of Oxides by Hydrogen

Masterton, W. L.; Demo, J. J., Jr.

J. Chem. Educ. 35,243 (1958)

Hydrogen is generated in a home-made glass apparatus wherein dilute sulfuric acid is allowed to drop on zinc metal. It passes over a weighed oxide heated with a burner. The spent hydrogen is burnt off at the exit of the tube. HAZARD: explosive potential, with flying glass splinters.

***INORG DEMO PREP REDOX SOLID 1 2**

Solid Phase Reduction of Salt Crystals

Mathur, P. B.

J. Chem. Educ. 39, A89 (1962)

CuSO4 crystals are covered with solid NaCl, filter paper, iron plate; jar is then filled with sat'd aq. NaCl. 24-hrs standing time converts CuSO4 crystals to pure Cu crystals. Extensions suggested.

*INORG PHYS HITEMP PHASE PREP SOLID STOICH XRAY 4

An Experiment in High Temperature Solid State Chemistry

McCarthy, G. J.

J. Chem. Educ. 49,209 (1972)

TiO₂-Ti system. Prep'n and x-ray characterization of a non-stoichiometric oxide, TiO (approx. 1), in sealed tubes under vacuum. Additional exp'ts outlined. Caution: the usual high temp., dust and fire prevention precautions when using metallic Ti must be observed.

*INORG PHYS APPARATUS COORD DEMO HEAT 2

A Thermochromic Demon Catcher

McGill, J.

J. Chem. Educ. 48,280 (1971)

Note on use of pink-blue color change of Co(II)-Cl⁻ solutions (aq. n-propyl alcohol) as used to illustrate change in complexation with temperature.

Simple apparatus for automation for demo purposes. The word "demon" is intended humorously.

*INORG PHYS APPARATUS ELECTROCHEM PREP SOLID 4 5

Electrochemistry in the Solid State

McKechnie, J. S.; Turner, L. D. S.; Vincent, C. A.; Lazzari, M. Scrosati, B.

J. Chem. Educ. 55,418 (1978)

Preparation of various solid electrolytes, e.g.((CH₃)₄N)2Ag13I15.

Various experiments include pressing into disks (e.g., IR pellet die), measuring conductance, investigating charge carriers, and use in the construction of solid state batteries. Very detailed. Requires audiofrequency AC bridge, voltmeter, constant current source.

*INORG PREP 1 2

A Practical Solvay Process Experiment

McKee, J. R.; Kauffman, J. M.

J. Chem. Educ. 58,1035(1981)

Solvay synthesis in 2 to 2.5 hrs by adding NaHCO₃. Illustrates generation and purification of a gaseous reactant (CO₂), limiting reagent, industrial process.

*INORG PREP 2 HAZARD

Synthesis of Potassium Tris(oxalato)aluminate(III) Trihydrate

McNeese, T. J.; Wierda, D. A.

J. Chem. Educ. 60,1001(1983)

Short note describes prep'n of title compound. Reference for analysis of product by permanganate titration. HAZARDS: SUSB has discontinued this experiment because of the large number of small hazards: 20% KOH, H₂ gas product, corrosive vapors, exothermic reaction, residues of unreacted aluminum (?) that must be filtered using glasswool,etc.

*INORG ANAL ORG COMPLEX MACROCYCLE PREP 4 HAZARD

Synthesis and Characterization of a Macrocyclic Nickel Complex;

An Experiment to Conclude an Advanced Inorganic or Analytical Course.

Merrell, P. H.; Urbach, F. L.; Arnold, M.

J. Chem. Educ. 54,580 (1977)

The complex 5,7,7,12,14,14-hexamethyl-1,4,8,11-tetraazocyclotetradeca-4,11-dieneatonickel (II) iodide is prepared in a two-step synthesis and analyzed for nickel, iodide (one method uses chloroform, HAZARD); characterization includes conductivity, spectroscopicmsmnts, nmr, etc.

*INORG PHYS COORD CRYO ESR PREP 4

Identification of Copper(II) Complexes in Aqueous Solution by Electron Spin Resonance; An Undergraduate Coordination Chemistry Experiment

Micera, G.; Deiana, S.; Erre, L.; Piu, P.; Panzanelli, A.

J. Chem. Educ. 61,646 (1984)

ESR spectra of the frozen solution species from Cu(II)-2,6-dihydroxybenzoate are determined at various pH. Inferences about structure are made. Brief description of the preparation.

*INORG HITEMP PHOSPHOR PREP UVIS 3 HAZARD

Simple Preparation of Phosphors

Mikus, F. F.

J. Chem. Educ. 40,362 (1963)

Furnace (900 deg. C). SiO₂ crucibles. Strong UV source. ZnS phosphors prepared. Warning: high temperature techniques. Furnace should be in hood. HAZARD: SbCl₃ is toxic; CdS carcinogenic, avoid.

*INORG TECHNIQUE TITN VACTEK 4

The Tensiometric Titration of Trimethylamine With Boron Trifluoride: An advanced inorganic laboratory experiment

Mills, J. L.; Flukinger, L. C.

J. Chem. Educ. 50,636 (1973)

Diagram of a high-vacuum line tensimeter given. Caution; air-sensitive gases.

***INORG CRYSTAL DEMO SOLID 1 2**

Detection of Water of Crystallization - Preparation of Oxygen

Mohamed, P. A.

J. Chem. Educ. 38 ,A89 (1961)

Mixtures of Na₂O₂ and hydrated salts, eg. MgSO₄·7H₂O, when warmed, evolve oxygen while anhydrous salts and sodium peroxide do not. A Chem-Ed Tested Demo.

***INORG ANAL DISTRIB NOPROC REDOX TITN 3 HAZARD**

Inorganic Reaction Mechanisms by Volumetric Analysis: Oxidation of Iodide Ion

Moody, G. J.; Thomas, J. D. R.

J. Chem. Educ. 40 ,151 (1963)

No procedure. Two steps in oxidation of I⁻ to I⁺ by CrO₃ elucidated by separation, titration. I₂ is extracted with CCl₄. HAZARDS: CrO₃, carcinogen; CCl₄, carcinogen (avoidable).

***INORG IR PREP VACTEK 5 HAZARD**

The Monomeric Pentacyanocobalt(II) Anion: Preparation and Properties of Thallium(I) Pentacyanocobaltate(II)

Mosha, D. M. S.

J. Chem. Educ. 59 ,1057(1982)

Research report suitable for adaptation to upper class experiment. Prep. method given, requires hi-vacuum apparatus (reference). Characterization by IR, magnetic measurements. HAZARD: KCN and thallium(I) sulfate are strong poisons.

***INORG ANAL DISTRIB IONX PREP TITN 2 HAZARD**

Preparation of Reagent-Grade Iron Oxide From Iron Ore: An experiment for freshman chemistry

Mulokozi, A. N.

J. Chem. Educ. 50 ,634 (1973)

Directions are skimpy. Extraction of iron with organic solvent as FeCl₄⁻ which is then isolated on strong base anion exchange resin. HAZARD: perchloric acid decomposition of minerals, some of which may be sulfides, or contain organic mat'l. Perchloric acid is also a storage hazard. Bibliographers suggest Na₂O₂ fusion instead.

***INORG ANAL COORD INSTR IR PREP PROJ 4**

The Characterization of a Coordination Complex Using Infrared Spectroscopy: An inorganic or instrumental experiment

Nathan, L. C.

J. Chem. Educ. 51 ,285 (1974)

Spectra by Nujol mull, KBr pellet, and CH₃CN solution for complexes: KSCN, K₂Hg(SCN)₄, K₂Co(NCS)₄, HgCo(SCN)₄, Ni(4-CN(Py))₄(CNS)₂, internal standard.

***INORG PREP 2 HAZARD**

The Preparation of PbI₂ From Galena

Nechamkin, H.; Dumas, P.

J. Chem. Educ. 55 ,681 (1978)

Complete easy procedure with study questions. HAZARD: H₂S evolved from PbS + 2HCl. Must be done with alkali trap to catch H₂S, and in hood. This is NOT STATED.

***INORG CONSUMERPROD ENVIRON PREP 2**

The Recovery of Silver from Film

Nechamkin, H.; Dumas, P. E.

J. Chem. Educ. 53 ,370 (1976)

Silver recovered by ashing film, dissolving in nitric acid. Ag collected by self-deposition on Cu wire. Caution: some sources say films may explode while ashing.

***INORG PHYS APPARATUS COMPLEX COMPUTER MAGNETIC PREP 4**

Measurement of the Magnetic Exchange in a Chlorobridged Cu(II) Dimer Adv.inorg. exp. employing the Faraday magnetic susceptibility system

Nelson, H. C.; Villa, J. F.

J. Chem. Educ. 57 ,385 (1980)

One-step prep. of trichloroguaniniumcopper(II) monohydrate dimer, visual absorption and variable temperature (77-300 K) magnetic susceptibility measurements. Latter gives ground state configuration and exchange interaction, 2J. Faraday balance, Cahn electrobalance, cryostat and assembly described by ref. Calc. of g by iterative computer program optional. Two 3 hr. periods.

***INORG COORD GEOM IR PREP 3**

The Preparation and Characterization of the Geometric Isomers of a Coordination Complex: cis- and trans-bis Glycinato Copper(II) Monohydrates O'Brien, P.

J. Chem. Educ. 59 ,1052(1982)

One lab period. Easy preparation and purification, followed by measurement and interpretation of IR spectra (nujol mulls) - far IR spectra required.

*INORG COORD ELECTROCHEM PREP 3

The Direct Electrochemical Synthesis of $((C_6H_5)_3P)_2(CoCl_4)$: An Example of the Use of Anodic Oxidation in the Preparation of Metal Ion Complexes
Oldham, C.; Tuck, D. G.

J. Chem. Educ. 59, 420 (1982)

Ph in title should be PH. Starting materials are cobalt metal, acetonitrile, and triphenylphosphine. The cobalt metal forms the anode. 6V battery serves as power source. Seems straightforward. Identification parameters (IR- KBr disk) given and extension suggested.

*INORG ANAL COLOR COORD GRAVIM PHOTO PREP TITN 2

Preparation and Analysis of Potassium Tris(Oxalato)Ferrate(III)Trihydrate
A General Chemistry Experiment

Olmsted, J., III

J. Chem. Educ. 61, 1098 (1984)

This experiment, which requires 5 3-hr. periods, includes analysis for water of hydration, oxalate by permanganate titration, and iron by photolysis (sunlight) to the Fe+2 state and precipitation as ferrous oxalate.

*INORG CATAL DEMO 2

Continuous Process for Catalytic Oxidation of Ammonia

Olmsted, M. P.

J. Chem. Educ. 41, A97 (1964)

Ammonia by aspirating air thru solution, platinum wire. A Chem Ed Tested Demo.

*INORG COORD PREP 2

Synthesis and Reactions of Cobalt Complexes

Olson, G. L.

J. Chem. Educ. 46, 508 (1969)

Cobalt(III)/NH₃. Easy preparations of several complexes. No characterization.

*INORG DEMO STOICH 2 HAZARD

Reaction Stoichiometry and Theoretical Yield

Ondrus, M. G.

J. Chem. Educ. 53, 228 (1976)

Ammonium dichromate volcano - weigh before and after; calc. yield.

Very spectacular.

HAZARD: Chromium(VI) is carcinogenic; dust is emitted. Perform only in hood. A tested demonstration.

*INORG GAS PREP 2

Nitrogen Oxides Experiments

Ophardt, C. E.

J. Chem. Educ. 53, 374 (1976)

NO and NO₂ generated and properties qual. demonstrated.

*INORG COORD DEMO KEQ 1 2

Cobalt Complexes in Equilibrium

Ophardt, C. E.

J. Chem. Educ. 57, 453 (1980)

Qualitative illustration of Le Chatelier's principle. Shift in equil. concs. of Co(II) aquo and chloro complexes seen as color change when water or chloride ion conc. changed. A tested Demo. See also Grant, A. W., Jr., J Chem Educ 61, 466 (1984).

*INORG COORD PREP REDOX UVIS 4 HAZARD

Synthesis and Spectra of Vanadium Complexes

Ophardt, C. E.; Stuppia, S.

J. Chem. Educ. 61, 1102 (1984)

The ultraviolet and visible spectra of various vanadium and vanadyl complexes illustrate the use of Orgel diagrams; d₂, d₂, d₃ and various geometries are included. Complete student handout available. HAZARD: HgCl₂.

*INORG DEMO PREP 1 2

Chemistry and Artists' Colors: Part III. Preparation and properties of artists' pigments

Orma, M. V., O. S. U.

J. Chem. Educ. 57, 267 (1980)

Chrome yellow (CAUTION: dichromates are carcinogens - here can be handled without danger if not contacted with skin), Prussian Blue, phthalocyanine blue, easy preparation for demo or project.

*INORG ANAL GLOVEB IR PREP QUANTUM UVIS 4

Preparation and Structural Characterization of Ammonium Hexafluorovanadate(II)

Sulfate: An advanced inorganic chemistry experiment

Patel, K. C.; Goldberg, D. E.

J. Chem. Educ. 50, 868 (1973)

Uvis spectrometer with reflectance attachment. Glovebox or N₂ purge.

Grav. anal. for sulfate. Ir spectra analyzed; group theory.

*INORG COORD IR PREP UVIS 2

The Preparation and Investigation of Bis(acetylacetonato) Copper(II)
Peacock, R. D.

J. Chem. Educ. 48, 133 (1971)

Simple preparation. Questions. Little characterization.

*INORG COORD DEMO MAGNETIC 2

Paramagnetism

Peng, Y.-T.

J. Chem. Educ. 40, A40 (1963)

(Fe₄Fe(CN)₆) complex diffuses toward magnetic field, or from it at a boundary between Fe(III) solution and K₄Fe(CN)₆ solution. A Chem Ed Tested Demo.

*INORG GRAVIM SOLID STOICH 2

A Demonstration in Solid State Chemistry: The Non-Stoichiometry of Nickel Oxide, NiO.

Ferrino, C. T.; Johnson, R.

J. Chem. Educ. 54, 367 (1977)

A grey nickel oxide Ni_{0.98}O obtainable from Baker Chem Co can be converted to the stoichiometric green NiO by heating. Oxygen is evolved.

Stoichiometry can be calculated from weight data. A Chem. Ed. Compact.

*INORG PREP REDOX 2 3

Some Tungsten Oxidation-Reduction Chemistry: A Paint Pot Titration

Pickering, M.; Monts, D. L.

J. Chem. Educ. 59, 693 (1982)

Two different redox agents with sodium tungstate produce a series of brightly colored products. Reductions: (a) tungstic acid, WO₃, by natural gas (procedure by reference) at red heat and (b) sodium tungstate by metallic zinc in solution. Permanganate titrations. Different mole ratios in two products is a challenge to students. Solution titn. gives brilliant redox color changes.

*INORG DEMO REDOX 1

Oxidation and Reduction of Iron

Poppel, S. M.; Abrahams, H. J.

J. Chem. Educ. 36, A17 (1959)

Chem-Ed Tested Demo. Simple inorganic reactions.

*INORG COORD PREP 3 HAZARD

The Preparation of Potassium Hexacyanocobaltate(III)

Poskozim, P. S.

J. Chem. Educ. 46, 384 (1969)

Easy prep. by two routes (one in inert atmosphere). HAZARD: cyanides should be avoided, even though used here in alkaline sol'n.

*INORG CHROMATOG COMPLEX IR PHOTO TLC 4 5

An Inorganic Laboratory Experiment Involving Photochemistry, Liquid Chromatography, and Infrared Spectroscopy

Post, E. W.

J. Chem. Educ. 57, 819 (1980)

Molybdenum carbonyl + tributylphosphine gives mixture of cis and trans. One lab for student pair if TLC omitted; otherwise 2. Open-ended for special projects. Column chrom. and IR are coupled by simple flow system to partially separate and detect components of mixture. Group theory and IR data determine stereochem of products.

*INORG COORD PREP UVIS 2

Synthesis and Spectral Study of Copper(II) Complexes

Potts, R. A.

J. Chem. Educ. 51, 539 (1974)

Glycine, acetylacetone complexes and their visible spectra.

*INORG IONX SEPARATION 1

The Separation of Rare Earths: A project for high school chemistry students

Powell, J. E.; Spedding, F. H.; James, D. B.

J. Chem. Educ. 37, 629 (1960)

Detailed instructions for construction of an ion-exchange column using equipment commonly available in high school laboratories. Polystyrene-divinylbenzene cation exchanger; sample is loaded as the chloride, eluted with HEDTA (hydroxy-ethyl-EDTA). The chloride solution is prepared from monazite rare-earth mixtures. All details given.

*INORG QUAL 1 2

A General Chemistry Experiment on the Identification of Reaction Products

Preer, J. R.

J. Chem. Educ. 52, 389 (1975)

Inorganic reactions are investigated as unknowns, using observation and a handbook.

*INORG CONSUMERPROD PH PREP 1

Making Baking Powder Biscuits
Rainey, R. G.

J. Chem. Educ. 39,363 (1962)

Class makes monocalcium phosphate - baking soda with pH control (indicator) by varying ratio, testing at home to see how biscuits turn out.

*INORG ANAL PHYS KEQ PH TITN 2

The Interaction of Chromium(III) Ion with Hydroxide Ion - an experiment for the undergraduate inorganic laboratory

Reinhardt, R. A.

J. Chem. Educ. 43,382 (1966)

Estimation of turbidity, eyedropper titration. Calculation of K_a , K_{sp} , etc.

*INORG IONX PREP 2

A Simple and Impressive Laboratory Exercise in Ion-Exchange

Renganathan, S.; Mehta, B. J.

J. Chem. Educ. 53,347 (1976)

A lab exercise to recover silver from AgCl precipitates as mixed silver and ammonium nitrates. Uses a cation exchange resin.

*INORG IR PREP 4 HAZARD

Infrared Spectroscopy of Tetrahedral Ligands: An advanced experiment in inorganic chemistry

Ribas, J.; Casabo, J.; Coronas, J. M.

J. Chem. Educ. 54,321 (1977)

Easy preparation and IR spectra of $(CrCrO_4(NH_3)_5)X$, where X = nitrate or perchlorate. The point of the experiment is to study the changes in the $CrO_4 =$ ion with ionic environment. HAZARD: chromates (respiratory, carcinogen); perchlorates (storage).

*INORG DEMO EXPLOSION KIN MAGIC 1 HAZARD

Decomposition of a Metallic Picrate

Rose, D. E.

J. Chem. Educ. 35,A26 (1958)

Picric acid + PbO (litharge). HAZARD: EXTREME EXPLOSIVE HAZARD. The alternative method described is a hazard to the eye. The mixing method described may cause a serious explosion. This exercise was intended as a demo for h.s. students. It is far too hazardous for them; people have been killed when mixing lead salts with picrates.

*INORG ACBA BIOCHEM COMPUTER COORD PH TITN 3

Determination of the Stability Constants of Nickel(II)-Cysteine

Rose, T. L.; Seyse, R. J.

J. Chem. Educ. 53,728 (1976)

Weighed samples of L-cysteine titd with std. NaOH in presence and absence of Ni^{++} ion. Computer analysis of data gives formation constants for two complexes.

*INORG APPARATUS DEMO MAGNETIC QUANTUM 2

A Simple Demonstration of O₂ paramagnetism: A Macroscopically Observable Difference Between VB and MO Approaches to Bonding Theory

Saban, G. H.; Moran, T. F.

J. Chem. Educ. 50,217 (1973)

Apparatus described which allows a stream of droplets of liq. O₂ to pass between the poles of a permanent magnet. O₂ droplets are deflected, liq. N₂ droplets are not.

*INORG DEMO EXPLOSION 2 HAZARD

Silver Acetylides

Sands, F. H.

J. Chem. Educ. 35,A38 (1958)

A Chem-Ed Tested Demo. HAZARD: explosive product, glass (home-made) equipment.

*INORG DEMO REDOX 2 HAZARD

Oxidation of PbO

Saurer, J. M.

J. Chem. Educ. 36,A61 (1959)

A Chem-Ed Tested Demo. In part a of the demo $KClO_3$ is heated in a test tube with yellow PbO until "blackening"; Pb_3O_4 forms on cooling. The Pb_3O_4 can then be further oxidized (part b) with conc. HNO_3 to PbO_2 . HAZARD: $Pb-ClO_3$ mixtures can detonate.

*INORG ASSOC SEPARATION SOLUB 2

Association of Ions and Fractional Crystallization

A General Chemistry Experiment

Scaife, C. W.; Dubs, R. L.

J. Chem. Educ. 60,418 (1983)

Fractional crystallization of $Ni(II), K^+/Cl^-, NO_3^-$ mixtures allows easy identification of products through differing colors of hydrates, anhydrous salts. Explicit with study questions. Majors and non-majors.

*INORG DEMO PREP 1

Synthesis of Copper(I) Sulfide
Scheer, R.

J. Chem. Educ. 36 ,A17 (1959)

Chem-Ed Tested Demo. Reaction of copper foil with a solution of sulfur in carbon disulfide yields Cu_2S . Caution: keep CS_2 away from flames.

*INORG DEMO EXPLOSION REDOX 2 HAZARD

Oxidation by Potassium Permanganate

Scheer, R.

J. Chem. Educ. 36 ,A21 (1959)

A Chem-Ed Tested Demo. $\text{KMnO}_4/\text{sugar/glycerine}$. HAZARD: explosive hazard. Emphatically not for a student experiment; included here to emphasize this.

*INORG CATAL DEMO PREP 2

Synthesis of Copper (II) Sulfide

Scheer, R.

J. Chem. Educ. 39 ,A75 (1962)

Copper sulfate solution provides a catalyst for the reaction of sulfur with copper powder. A Chem Ed Tested Demo.

*INORG ANAL REDOX TITN 3

The Use of Inorganic Redox Mechanisms in Analytical Chemistry
Schenk, G. H.

J. Chem. Educ. 41 ,32 (1964)

Experimental study of As(III)-I_2 reaction leads to hypotheses about mechanism, and extensions (mostly citing lit.) to irreversible redox reactions. Some extensions possible.

*INORG ANAL ACBA ELECTRODE HITEMP MOLTENSALT TITN 5 HAZARD

Lewis Acid-Base Titration in Fused Salts

Schlegel, J. M.

J. Chem. Educ. 43 ,362 (1966)

Construction of electrodes. The titration by addition of sodium carbonate to sodium-potassium nitrate fused bath containing a Lewis acid, dichromate ion, using oxygen bubbler. HAZARD: strongly oxidizing melt; dichromate is a carcinogen. This expt was developed for freshmen, but would be unsafe with anything but very small advanced classes.

*INORG LASER LUMIN 4

Luminescent Processes Elucidated by Simple Experiment on ZnS
Schwankner, R.; Eiswirth, M.; Venghaus, H.

J. Chem. Educ. 58 ,806 (1981)

Impurity-related optical properties of semiconductors. ZnS screen, doped ZnS screen, glass Dewar, liquid N_2 , He/Ne gas laser.

*INORG HISTORIC PREP 2

Experiments in Alchemy, Part I. Ancient Arts

Schwartz, A. T.; Kauffman, G. B.

J. Chem. Educ. 53 ,136 (1976)

Simple preparations, reductions of metal oxides, preparations of alloys, paints, lime, soap. Excellent text. Instructions are precise.

*INORG HISTORIC MAGIC PREP 2

Experiments in Alchemy II. Medieval Discoveries and Transmutations

Schwartz, A. T.; Kauffman, G. B.

J. Chem. Educ. 53 ,235 (1976)

See part I (this volume, p.136). Continues with acids, bases, "transmutations" and other nice things. Warning: some explosives in this experiment.

*INORG PREP SEQ 2

The Chemistry of Silver: A demonstration sequence

Schwenck, J. R.

J. Chem. Educ. 36 ,45 (1959)

Minimal directions. Flow chart.

*INORG ACBA CONSUMERPROD 2

Research Project for General Chemistry Laboratory

Schwolow, J.

J. Chem. Educ. 35 ,416 (1958)

"In vitro" treatment of "acid stomach" with antacids. Buffer capacity measured.

*INORG ANAL COORD PREP 2

Preparation and Analysis of a Complex Compound

Sebera, D. K.

J. Chem. Educ. 40 ,476 (1963)

Chloropentamminecobalt(III) chloride prepared and analyzed. Detailed procedures for prep. only. Analysis by Mohr, ion exchange for remaining chloride, cobalt by redox.

*INORG ORG PHYS ESR FREERAD MISTAKE NOPROC 4

Two ESR Systems for the Advanced Undergraduate Laboratory
Serianz, A.; Shelton, J. R.; Urbach, F. L.; Dunbar, R. C.
Kopczewski, R. F.
J. Chem. Educ. 53, 394 (1976)
N,N-dibenzyl nitroxide radical; and bis-(acetylacetonato)oxyvanadium(IV).
Preparation by reference. Outline of experiment used in teaching room
temp. ESR. Part of the title seems to be missing (?) from the article.
See also Borer, L. > L., J. Chem. Ed. 59, 1065 (1982) for use of two dif-
ferent vanadyl complexes.

*INORG PHYS DEMO KIN LUMIN QUANTUM 3 4 HAZARD

Singlet Oxygen in Aqueous Solution: A Lecture Demonstration
Shakhashiri, B. Z.; Williams, L. G.
J. Chem. Educ. 53, 358 (1976)
Lecture-scale production of red glow of excited gaseous oxygen by (1) bub-
bling Cl₂ into 30% H₂O₂ (caution: froths) and (2) from halogen/CCl₄/H₂O₂
reaction. Sketch of (simple) apparatus. Detailed description and molecular
orbital description of the phenomenon. A tested demonstration. Emphasis
on large lecture; can do a simpler version for a small group or closed-
circuit TV. HAZARDS: halogens (toxic), CCl₄ (carcinogen), etc.

*INORG COMPLEX DEMO KEQ KSP 1 2 HAZARD

Solubility and Complex Ion Equilibria of Silver(I) Species in Aqueous
Solution
Shakhashiri, B. Z.; Dirreen, G. E.; Juergens, F.
J. Chem. Educ. 57, 813 (1980)
Visual demonstration of relative stabilities of nine Ag(I) species.
Observations explained in terms of ionic equilibria. K_{sp} and formation
constants tabulated. Sample calculations and student problems given.
HAZARD: cyanide ion, poison - avoid acids; ammonia and silver solⁿs
are skin irritants. A Tested Demo.

*INORG COLOR COMPLEX DEMO KEQ 2 3 HAZARD

Color, Solubility, and Complex Ion Equilibria of Nickel(II) Species in
Aqueous Solution
Shakhashiri, B. Z.; Dirreen, G. E.; Juergens, F.
J. Chem. Educ. 57, 900 (1980)
Colors and relative stabilities of seven Ni(II) complexes demonstrated.
Formation constants and geometries given. Like Shakhashiri et al 57,
813, but more advanced. HAZARD: reagents used are poisons, suspected
carcinogens, or tissue irritants.

*INORG COLOR CRYO DEMO MAGNETIC UVIS 2 3 HAZARD

Paramagnetism and Color of Liquid Oxygen: A Lecture Demonstration
Shakhashiri, B. Z.; Dirreen, G. E.; Williams, L. G.
J. Chem. Educ. 57, 373 (1980)
Prep. of liquid oxygen described. Behaviors of liquid oxygen and
nitrogen in magnetic field demonstrated and explained using MO theory.
MO and electron PE diagram for O₂ given. HAZARD: pure O₂, supports
supports violent combustion. A Tested Demo.

*INORG IR NMR PREP 2

Co(acac)₃: Synthesis, Reactions, and Spectra: An experiment for general
chemistry.
Shalhoub, G. M.
J. Chem. Educ. 57, 525 (1980)
Introduction to spectroscopy. Vacuum filtration, recrystallization, m.p.
Three 3-hour lab periods. Like a mini-research project.

*INORG ELECTROCHEM HITEMP PHOTO PREP SOLID 3 HAZARD

Experiments with Photoconductive Cadmium Sulfide
Sheehan, W. F.
J. Chem. Educ. 39, 540 (1962)
Prep. sulfide from thioacetamide and CdCl₂, doped with CuS. Porcelain
plate fired to 600 deg. C, 500V DC source, conductive silver paint.
HAZARDS: CdS, thioacetamide - carcinogens; high voltage hazard.

*INORG CLOCK DEMO KIN MAGIC 0

A Few Chemical Magic Tricks Based on the Clock Reaction
Shigematsu, E.
J. Chem. Educ. 56, 184 (1979)
Variations on the KIO₃-NaHSO₃ clock. Explicit. Straightforward.

*INORG COORD KEQ 1

Coordination Complexes and Equilibrium
Shombert, D. J.
J. Chem. Educ. 47, A784(1970)
Reaction of Cu⁺ + /iron(nails) in presence and absence of excess NH₃.

***INORG PHYS CORROSION DEMO REDOX 2**

Corrosion: Proceedings of the California Association of Chemistry Teachers
Slabaugh, W. H.

J. Chem. Educ. 51, 218 (1974)

Some simple tests on corrosion inhibition, including iron, steel and aluminum. Passive iron and steel, cathodic protection, inhibitors, stress. Caution: ball bearings may rupture explosively.

***INORG ANAL CALORIMETRY COMPLEX GRAVIM PREP STOICH 2**

The Preparation and Analysis of Some Double Salts: An introductory experiment

Snively, F. A.; Yoder, C. H.

J. Chem. Educ. 48, 621 (1971)

M(I)2SO4-M(II)SO4.nH2O crystals where M(I) is K or ammonium, M(II) is Cu, Ni, Co, Zn, prepared and analyzed. Drying to constant weight, gravimetric, calorimetric methods outlined only. Extensions.

***INORG PREP VACTEK 4 5 HAZARD**

The Preparation of Aminoboranes: Two high vacuum experiments for the inorganic chemistry laboratory

Spielman, J. R.

J. Chem. Educ. 47, 225 (1970)

Diborane prep. by reference. Warning: diborane, hydrogen evolved, extremely hazardous for uninstructed persons. These instructions are not detailed.

***INORG GLOVEB ORGANOMETAL PREP 4 HAZARD**

The Nitrogen Glove: A technique for handling air-sensitive compounds

Srinivasan, S. C.; Wiles, D. R.

J. Chem. Educ. 48, 348 (1971)

Devised for studying organometallic compounds on very small scale.

Preparation of manganocene and methylmanganese carbonyls. Characterized by gc. HAZARD: metal carbonyl toxicity.

***INORG REDOX TITN 2**

The Oxidation States of Molybdenum

Stark, J. G.

J. Chem. Educ. 46, 505 (1969)

Reduction of Mo(VI) to Mo(V) by Hg and to Mo(III) by Zn(Hg) measured by cerium(IV) titration. Caution: Hg toxicity.

***INORG HITEMP PREP 3**

Procedure for Recovering Elemental Silver from Silver Residues

Steed, S. P.; Hayes, J. M.

J. Chem. Educ. 49, 156 (1972)

By a metallurgical technique. Silver is smelted from AgCl, etc., residues.

***INORG FLUOR HITEMP LUMIN PREP SOLID 4**

Preparation of a Phosphor, ZnS:Cu2+

Suib, S. L.; Tanaka, J.

J. Chem. Educ. 61, 1099 (1984)

The experiment is the preparation of copper doped ZnS in a tube furnace. Excluding impurities is important. Luminesces under UV. Ag doping gives blue glow under vacuum/electronic excitations; Mn glows orange at 1-2% (not ppm) conc. (JZ). Specially prepared ZnS is needed. A good short review of phosphorescence and luminescence is included.

***INORG PHYS SURFACE 2 3 HAZARD**

Surface Conductive Glass

Tanaka, J.; Suib, S. L.

J. Chem. Educ. 61, 1104 (1984)

A simple process for preparation of surface conducting SnO2 film on glass substrates. The testing and applications of coated glasses are outlined.

Requires oven at 600°C. HAZARD: benzene, carcinogen, should be avoided; tin and antimony compounds in spray are toxic.

***INORG ANAL COORD NOPROC PREP PROJ 2**

A Project-Type General Chemistry Experiment

Thielmann, V.

J. Chem. Educ. 51, 536 (1974)

Chloropentamminecobalt(III) chloride preparation and analysis as a project. Most has appeared earlier.

***INORG COORD GLOVEB PREP 3 HAZARD**

The Synthesis and Characterization of Tin Complexes Using Inert Atmosphere

Techniques: An advanced laboratory experiment

Thompson, D. W.; Kranbuehl, D. E.; Schiavelli, M. D.

J. Chem. Educ. 49, 569 (1972)

SnCl4-acetylacetone adduct, cis-dichlorobis(acetylacetonato)Sn(IV) prepared.

Dry box or glove bag. Ir, nmr, etc. suggested. HAZARD: benzene is carcinogen; substitute another solvent.

*INORG ANAL REDOX STOICH TITN 2

Some Experiments on the Stoichiometry of Reactions

Tietze, H. R.

J. Chem. Educ. 40 ,344 (1963)

Five different reactions using ordinary lab reagents.

*INORG DEMO LUMIN PHOSPHOR PREP 2 HAZARD

Luminescent Compounds, ie. Phosphors

Tietze, H. R.

J. Chem. Educ. 40 ,A49 (1963)

Strontium sulfide and cadmium chlorophosphate phosphors. Requires 800-1000

deg. C. HAZARD: cadmium compounds are carcinogens. A Chem Ed Tested Demo.

*INORG ORG APPARATUS HITEMP ORGANOMETAL PREP VACTEK 5 HAZARD

Transition Metal Vapors in Chemical Synthesis: The direct preparation of dibenzene chromium as an undergraduate experiment

Timms, P. L.

J. Chem. Educ. 49 ,782 (1972)

Chromium is sublimed at 1500 deg. C under high vacuum and the vapor condensed together with benzene vapor on a liq. N₂-cooled surface. Diagram of chamber given. HAZARD: benzene, but handled on vac. line.

*INORG PHYS COORD QUANTUM 3

Crystal Field Spectra of Transition Metal Ions: A physical chemistry experiment

Trapp, C.; Johnson, R.

J. Chem. Educ. 44 ,527 (1967)

Max. in absorption over 340-950 nm. by solutions of various transition metal salts plotted using a Bausch and Lomb Spectronic 20. Positions of maxima used to calc. crystal field stabilization energy.

*INORG ANAL PHYS COORD DTA IR NOPROC PREP 4 5

Preparation and Properties of Sulfatotris(thiourea)zinc(II)

Udupa, M. R.

J. Chem. Educ. 57 ,825 (1980)

Twelve lab hours. Large crystals grown and analyzed. Experimental details referenced.

*INORG PREP 1 2

An Improved Copper Cycle Experiment

Umans, T.; DeVos, W.

J. Chem. Educ. 59 ,52 (1982)

Authors point out that experiment makes more sense to students if the final product looks like copper as the students know it: suggest use decomp. of cupric acetate as final step: yields a shiny plate. Not quantitative.

*INORG DEMO PREP 1

Polymorphic Forms of Mercuric Iodide

VanCamp, C. O.

J. Chem. Educ. 37 ,A27 (1960)

Conversion of red mercuric oxide to yellow mercuric oxide by heating.

A Chem-Ed Tested Demo.

*INORG PHYS EXCHANGE IONX KIN NMR STOICH 4 HAZARD

A Room-Temperature Proton Magnetic Resonance Hydration Number Study

Vidulich, G. A.; Fratiello, A.

J. Chem. Educ. 55 ,672 (1978)

Dil. sol'ns of aluminum perchlorate nonahydrate in deuterated acetone have slow exchange rates. Hydration number by integration, conc. by titration after cation exchange. HAZARD: perchlorates - storage hazard.

*INORG CATAL DEMO PROJ REDOX 2

Catalytic Oxidation of Manganese (II) Sulfate

Villarreal, F. G.

J. Chem. Educ. 39 ,A55 (1962)

Silver ion catalyzes reaction with persulfate. Mechanism only by "probably". Possible project: effect of other ions, pH? A Chem Ed Tested Demo.

*INORG DEMO PREP REDOX 2

Displacement Reactions - Spongy Tin

Villarreal, F.; Garcia, O.

J. Chem. Educ. 38 ,A63 (1961)

Reduction of SnCl₂ solution with granular zinc.

***INORG PHYS COORD KIN UVIS 3**

Kinetics of the Anation of Aquopentaamminecobalt(III) by Thiocyanate: A Physical-Inorganic Chemistry Experiment
Vinaixa, J.; Ferrer, M.

J. Chem. Educ. 60,155 (1983)

The displacement of H₂O by NCS⁻ is a second order reaction, here measured using a large excess of NCS⁻ (pseudo first order). The reaction is followed spectrophotometrically. Preparation of the complexes (by ref.) involves the use of perchloric acid and solid perchlorates. CAUTIONS are given. Group or multiperiod experiment.

***INORG COLOR COORD DEMO PHOTO REDOX 1 2**

The Ferrioxalate Actinometer: A lecture demonstration
Vitz, E. W.

J. Chem. Educ. 58,655 (1981)

Photochemical redox reactions illustrated by photo reduction (photographic strobe lamp) of Fe(III) to Fe(II) which complexes with 1,10-phenanthroline to produce red color. Fe(III) sulfate may replace the oxalato complex.

***INORG DEMO MAGNETIC 2**

Paramagnetic Properties of Fe(II) and Fe(III)

Walker, N.

J. Chem. Educ. 54,431 (1977)

Suspend test tubes, approx. 1/4th full of powdered iron(III) sulfate, iron(II) sulfate, K₃Fe(CN)₆ and K₄Fe(CN)₆, with light weight twine. Bring up a small strong magnet, such as Edmund's #70572. A tested demonstration.

***INORG DEMO ELECTROCHEM REDOX 1 2**

Synthesis and Decomposition of ZnI₂

Walker, N.

J. Chem. Educ. 57,738 (1980)

Striking visual demo. of rapid reaction of Zn and I₂ in presence of water to form zinc iodide. Exothermic reaction. Resulting sol'n electrolyzed to reform Zn and I₂. Suitable for overhead projector. Caution: iodine, tissue irritant. A tested demo.

***INORG QUANTUM 2**

General Chemistry Exercise Using Atomic and Molecular Orbital Models

Walker, R. A.

J. Chem. Educ. 42,672 (1965)

Styrofoam balls, pipe cleaners, paint used to make atomic, orbital, and molecular models.

***INORG DEMO MAGIC 1**

A Unique Demonstration Show for the Elementary School Classroom

Waterman, E. L.; Bilsing, L. M.

J. Chem. Educ. 60,415 (1983)

Several documented demonstrations described as useful for elementary programs; some could be used as experiments at level 1 with modification.

***INORG COORD MAGNETIC PREP PROJ UVIS 4 HAZARD**

Magnetic and Spectral Behavior of Co(py)₂X₂ Complexes

Webb, D. L.; Meek, T. L.

J. Chem. Educ. 55,408 (1978)

X = I⁻, Br⁻, Cl⁻, SCN⁻, N₃⁻, CN⁻. Minimal directions. Electronic and reflectance spectra, mag. moments given. HAZARDS: cyanides and azides are toxic; chloroform is a carcinogen.

***INORG PREP STOICH 1 2**

A Different Experiment on Chemical Composition

Wells, N.; Boschmann, E.

J. Chem. Educ. 54,586 (1977)

Synthesis of antimony iodide from metal can be used to establish formula. Easy.

***INORG COORD GEOM IONX PREP 2 3**

Preparative and Ion Exchange Studies on the Cobalt(III)-Iminodiacetate System : A laboratory experiment

Weyh, J. A.

J. Chem. Educ. 47,715 (1970)

Iminodiacetate is a tridentate ligand. However, three isomers of Co(III) are possible, cis, trans(facial) and trans(meridional). Explicit directions for prepn of two of these isomers and ion-exchange separation of isomer mixture.

***INORG COURSE 2**

Descriptive Chemistry in the General Chemistry Laboratory

A Learning Cycle Approach

Whisnant, D., M.

J. Chem. Educ. 59,792 (1982)

A collection of experiments which emphasize descriptive chemistry, organized with learning cycles to introduce principles in the laboratory.

***INORG ELECTROANAL IR NMR PREP 4 5**

Synthesis and Electrochemistry of Cyclopentadienylcarbonyliron Tetramer:
An advanced experiment

White, A. J.; Cunningham, A. J.

J. Chem. Educ. 57,317 (1980)

Cyclic voltammetry analysis shows that removal or addition of an electron in a molecular orbital has consequences for the entire molecule. Gain or loss affects entire cluster compound, including ligands, symmetrically.

CAUTION: hood required for CO evolved; ground glass connections must be secured.

***INORG APPARATUS CATAL DTA 4**

Influence of Temperature and Catalyst on the Decomposition of Potassium Chlorate in a Simple DTA Apparatus

Wiederholt, E.

J. Chem. Educ. 60,431 (1983)

Homemade DTA system described; requires a 2-channel y/t plotter. Data for DTA curves of CuSO₄·5H₂O and KClO₃ with and without catalyst presented.

***INORG ANAL GRAVIM STOICH 2**

The Law of Definite Proportions: An experiment for introductory chemistry

Wilhelm, D. L.

J. Chem. Educ. 50,436 (1973)

Exposure of copper foil to iodine vapor yields tough white coating of CuI.

This can be dissolved by thiosulfate solution. Weigh foil before and

after iodine reaction, again after removing compound, drying w. acetone.

Caution: iodine vapors (toxic), acetone (fire)

***INORG ANAL COORD PREP PROJ UVIS 2**

A Research Approach in the Introductory Laboratory

Wilson, L. R.

J. Chem. Educ. 46,447 (1969)

Prep'n of four or more Co(III) complexes with NH₃, ethylenediamine, chloride. Colorimetric analysis for cobalt.

***INORG GC PHOTO PREP QUAL TITN 4 HAZARD**

A Comparison of Ionic and Covalent Iodine Dihalides: An integrated experiment

Woolf, A. A.

J. Chem. Educ. 55,738 (1978)

Prep. of potassium dibromiodate and phenyl iodine dichloride; thermal and photo reactions of latter. Minimal experimental and analytical directions.

Much discussion. Selective tests for halide ions in the mixture given.

Special easily-blown reaction tube. Characterization by GC, vol. anal., etc. HAZARD: CHCl₃ - carcinogen.

***INORG DEMO FLUOR LASER OPTICAL PREP 2**

Preparation of a Fluorescent Rare Earth Complex

Workman, M. O.

J. Chem. Educ. 48,303 (1971)

Procedure for prep'n of Eu(III)-dibenzoylmethane-piperidine complex (a laser material) for use in demonstration.

***INORG ASSOC NMR PREP SEPARATION 4 HAZARD**

The Two Forms of Aluminum Isopropoxide: An NMR experiment

Worrall, I. J.

J. Chem. Educ. 46,510 (1969)

Tetramer and trimer preparations (vac. distillation, heating in sealed tube), structure by nmr. HAZARD: benzene, solvent, use a substitute.

***INORG PHYS ACBA KEQ KIN 4 HAZARD**

Hydrolysis of Group IV Chlorides

Yoder, C. H.

J. Chem. Educ. 46,382 (1969)

Det'n and comparison of extents and rates of hydrolysis of trimethylchlorosilane and trimethylchloromethane (ie., tert-butyl chloride).

Techniques used: titration, distillation, refr. index, density. HAZARD:

TMS is corrosive, toxic, flammable, and causes serious burns.

***INORG REDOX STOICH 1 HAZARD**

The Reduction of CuO with Burner Gas Without a Fume Hood: A high school chemistry experiment

Zidick, C.; Weismann, T.

J. Chem. Educ. 50,717 (1973)

Copper oxide reduction with methane, formula by weight change.

Hazard: As described, the experiment involves an explosive hazard.

Reader (DT) comments that he has done the expt using carbon dioxide instead

of methane with satisfactory results. See also Hoffman, A.B.; Hoffman, A.J.,

J. CHEM. EDUC., 51, 418 (1974) for some modifications and extensions.

*INORG QUAL 1 2

The Case of the Unlabeled Bottles: Descriptive chemistry in the introductory laboratory course

Zuehlke, R. W.

J. Chem. Educ. 43,601 (1966)

Given seven solutions in unlabeled bottles (with some qual. unknowns), how can mixing determine the contents? A master list of all possible substances used is also given.

*ORG FREERAD GC 3

Free Radical Chlorination

Adduci, J. M.; Dayton, J. H.; Eaton, D. C.

J. Chem. Educ. 48,313 (1971)

Reaction of 2,4-dimethylpentane with sulfuryl chloride or N-chlorosuccinimide to demonstrate free radical reactions and relative reactivity of primary, secondary, tertiary H.

*ORG FRIEDEL-CRAFTS PREP 3 4

The Friedel-Crafts Pathway to Diarylcyclopropanes: An Undergraduate Organic Experiment

Agranat, I.; Tapuhi, Y.

J. Chem. Educ. 53,531 (1976)

Prepn. and spectral properties of di-2,4-xylylcyclopropanone from tetrachlorocyclopropane. Some discussion of aromaticity.

*ORG GC ISOMERS PREP 3

The Dimerization of Isobutylene: A student experiment

Allen, M.; Joyner, C.; Kubler, P. G.; Wilcox, P.

J. Chem. Educ. 53,175 (1976)

Short note reports successful classroom repetition of Whitmore's classic dimerization on a small scale, analysis of octene isomers by GC.

*ORG HETEROCYCLIC PREP 3 HAZARD

Preparation of 2-Arylimidazo-(2,1-b)Benzothiazoles

Alper, H.

J. Chem. Educ. 47,223 (1970)

Students are given the method of prep'n of 2-phenylimidazo-(2,1b) benzothiazole (from 2-aminobenzothiazole and 2-bromoacetophenone) and asked to prepare it or p- substituted derivative (given the appropriate substituted acetophenone). 2 periods. HAZARD: 2-bromoacetophenone is a persistent lachrymator. Reader suggests 2-bromoacetophenone is a confusing name: use omega-.

*ORG IR NMR PREP TAUTOMERS 3 HAZARD

Ring-Chain Tautomerism: An experiment in organic chemistry

Alper, H.; Alper, A. E.; Taurins, A.

J. Chem. Educ. 47,222 (1970)

2-benzimidazolinethione (2-mercaptobenzimidazole) and chloroacetone are condensed. Tautomeric equilibrium studied, ir, nmr. Two periods. Extension suggested. HAZARD: chloroacetone is a lachrymator.

***ORG ADDITION DEMO NATPROD PREP 1**

The Bromination of Acrolein

Alyea, H. N.

J. Chem. Educ. 37 ,A49 (1960)

Bromine vapor is decolorized by a freshly-cooked strip of bacon.

A Chem-Ed Tested Demo.

***ORG HETEROCYCLIC LUMIN PREP SEQ 3**

The Preparation of Lucigenin: An Experiment with Charm

Amiet, R. G.

J. Chem. Educ. 59 ,163 (1982)

Complete, detailed. Starting material is o-chlorobenzoic acid. The product is chemiluminescent.

***ORG NAME NMR PREP SEQ 3**

A Crossed Aldol Condensation for the Undergraduate Laboratory

Angres, I.; Ziegler, H. E.

J. Chem. Educ. 51 ,64 (1974)

Two-step sequence: (1) fluorene carbanion reacts with benzaldehyde in benzyl alcohol solution yielding 9-benzalfluorene, (2) reduction to 9-benzylfluorene by refluxing w. KOH/benzyl alcohol at 205 deg. C. Identification parameters and alternate 1-step procedure.

***ORG INORG POLYMER PREP 3**

The Preparation of "Bouncing Putty": An undergraduate experiment in silicone chemistry

Armitage, D. A.; Hughes, M. N.; Sinden, A. W.

J. Chem. Educ. 50 ,434 (1973)

Explicit directions. Starting material is dimethylsilicon dichloride.

***ORG IR ISOMERS NMR PREP PROJ PROOF 3 HAZARD**

Structural Determinations in Organic Chemistry: Synthesis of Isomeric Allylic Alcohols

Arnaud, C.

J. Chem. Educ. 51 ,819 (1974)

Isophorone reactions; products studied by nmr, ir. Extended project.

HAZARDS: LiAlH₄, chromic acid, 98% hydrazine.

***ORG REARRANGE SEQ 4**

Highly Stereoselective Synthesis and Rearrangement of b-Amino a-Bromo Chalcones

Arnould, J. C.; Feigenbaum, A.; Henin, F.

J. Chem. Educ. 60 ,82 (1983)

Intended for advanced students: the individual steps in the sequence are easy; the entire sequence can be performed in one long lab period. However, previous experience is assumed; experimental directions given as if in a journal.

***ORG PREP 2 HAZARD**

Simple Method For The Preparation of 2,4-Dinitroaniline

Ashton, A. A.

J. Chem. Educ. 40 ,545 (1963)

2,4-Dinitrochlorobenzene and aq. NH₃. Reaction is simple, but Reader (DT) points out that 2,4-DCB is a bad actor - causes a nasty skin rash. It has been taken out of many labs.

***ORG CHIRAL ISOMERS POLARIM RESOLUTION 2 3**

Resolution of D,L-Alpha-Phenylethylamine

Ault, A.

J. Chem. Educ. 42 ,269 (1965)

Fractional crystallization of D-tartrates.

***ORG GC PREP SEQ 3 HAZARD**

A Three-Step Synthesis: 2,4-Dinitrophenylhydrazine From Benzene

Ault, A.

J. Chem. Educ. 42 ,267 (1965)

Reaction sequence, standard methods. HAZARD: benzene, bromine.

***ORG CLATH PREP REARRANGE 3 HAZARD**

Preparation of Adamantane

Ault, A.; Kopet, R.

J. Chem. Educ. 46 ,612 (1969)

Adamantane from tricyclo(5.2.1.0-2.6)decane (inexpensive). Thiourea inclusion complex. HAZARD: thiourea is a carcinogen.

***ORG PREP TCHROM 3 HAZARD**

Two Thermochromic Compounds: Preparations for the introductory organic laboratory
Ault, A.; Kopet, R.; Serianz, A.
J. Chem. Educ. 48, 410 (1971)
Xanthone, xanthene, anthrone and 9-bromoanthrone (prep'ns by reference) required. Thermochromism (no discussion) shown on melting solids or during recrystallization from mesitylene. HAZARD: bromine

***ORG PHOTO PREP TAUTOMERS 3 HAZARD**

A Photochromic Compound: A Preparation for the Introductory Organic Laboratory
Ault, A.; Kouba, C.
J. Chem. Educ. 51, 395 (1974)
Prep'n of 2-(2,4-dinitrobenzyl)pyridine by nitration of 2-benzylpyridine. Crystals turn reversibly deep blue in sunlight. Explicit directions.
HAZARD: fuming nitric acid. See also Zaczek, N.M.; Levy, W.D.; Jordan, M.L.; Niemeyer, J.A., J. Chem. Educ. 59, 705 (1982) for a smaller scale modification.

***ORG PREP SEQ 3 HAZARD**

1-Bromo-3-Chloro-5-Iodobenzene: An Eight-Step Synthesis From Benzene
Ault, A.; Kraig, R.
J. Chem. Educ. 43, 213 (1966)
React sequence, 6 periods. HAZARDS: benzene, chlorine, iodine monochloride.

***ORG CARBENE CATAL PREP PTC 3**

2,2-Dichlorobicyclo(4.1.0)heptane from Cyclohexene and Dichlorocarbene by Phase Transfer Catalysis
Ault, A.; Wright, B.
J. Chem. Educ. 53, 489 (1976)
Improved preparation (see Goh, S.H.J., J. CHEM. EDUC., 50, 678(1973)).
Caution: chloroform.

***ORG CATAL PREP 4 HAZARD**

A New Synthesis of Tertiary Alkyl N-Arylcarbamates From Isocyanates
Bailey, W. J.; Griffith, J. R.
J. Chem. Educ. 55, 809 (1978)
New procedure for preparation of derivatives for identification of tertiary alcohols from phenyl(naphthyl) isocyanates. Alkoxide catalyst.
Not really a student experiment. HAZARD: Li metal.

***ORG CLATH DISTRIB PROJ PTC REVIEW 3 4**

Poly(ethylene Glycol): A Poor Chemist's Crown
Balasubramanian, D.; Chandani, B.
J. Chem. Educ. 60, 77 (1983)
Not an experiment. The article describes several types of expts using PEG in place of more expensive crown ethers. Extensive references. Several projects could be derived from this.

***ORG CHIRAL POLARIM PREP RESOLUTION 4**

Determination of the Absolute Stereochemistry of Secondary Alcohols: An advanced organic chemistry experiment for undergraduate students
Bandaranayake, W. M.
J. Chem. Educ. 57, 828 (1980)
Prep. of 2-phenylbutanoic acid (uses liquid NH₃ and NaNH₂) given and its conversion to the anhydride. Then reaction of anhydride with (+) borneol on a small scale, titration of unesterified acid and polarimetry used (Horeau method). Calculations clearly explained.

***ORG CHIRAL ISOMERS POLARIM 3 4**

Determination of The Relative and Absolute Configurations of (-) Menthol and (+) Neomenthol: An introductory stereochemistry experiment
Barry, J.
J. Chem. Educ. 50, 292 (1973)
Menthone reactions give inference about stereochemistry. Do not let students read article before doing experiment.

***ORG PHYS COMPUTER FREERAD GC KIN VACTEK 4**

A Student Experiment For Measuring Rate Constants of Radical Recombination
Bartle, K. D.; Butcher, P. G.; Harding, O. J.; Roberts, B. R.
J. Chem. Educ. 55, 742 (1978)
Radical buffer method. Di-tert-butyl peroxide, iodoalkanes. Complicated kinetics, simplifying assumptions permit recombination rate constants. Analysis of products by quantitative GC requires computer program (available).

***ORG NATPROD PHEROMONES PREP PREP PROJ 4**

Synthesis of Frontalin, the Aggregation Pheromone of the Southern Pine Beetle: A Multistep Organic Synthesis for Undergraduates
Bartlett, P. A.; Others
J. Chem. Educ. 61, 816 (1984)
The synthesis of frontalin, 1,5-dimethyl-6,8-dioxabicyclo(3.2.1)octane, from 3-methyl-3-buten-1-ol is a project for honors students. Five steps include acetoacetic ester condensation, epoxidation, and isomerization. Detailed, but some parts are for instructor's information only.

***ORG SOLUB TECHNIQUE 3**

Solvent Selection For Recrystallization: An undergraduate organic chemistry experiment

Baumann, J. B.

J. Chem. Educ. 56 ,64 (1979)

Elementary technique for solvent selection for unknown. Examples.

***ORG NOPROC PREP SUBST.RXN 3**

Directive Effects in Electrophilic Aromatic Substitution: An organic chemistry experiment

Beishline, R. R.

J. Chem. Educ. 49 ,128 (1972)

A "proof-of-structure" experiment is described. Bromination of acetanilide in glacial HOAc.

***ORG PHYS CATAL GC HPRESS KIN 4**

The Olefin Metathesis Reaction: An experiment in heterogeneous catalysis

Bennett, D. W.

J. Chem. Educ. 57 ,672 (1980)

Conversion of propylene to ethylene and 2-butene using a tungstic acid-silica catalyst in a continuous flow, fixed-bed reactor at 50 psig and 400 deg. Celsius. Emphasis is on the catalyst. Analysis of products by GC.

***ORG ISOMERS NMR PREP PROOF 3**

Structure Elucidation: An organic chemistry experiment

Benson, B. W.; Olsen, E. S.; Smeltz, L. A.

J. Chem. Educ. 47 ,220 (1970)

Prep'n. of two isomeric products from methone (5,5-dimethyl-1,3-cyclohexanedione) and salicylaldehyde. Nmr structure det'n.

***ORG PHEROMONES PREP REDOX 3**

Sulcatol: Synthesis of an Aggregation Pheromone

Black, S. A.; Slessor, K. N.

J. Chem. Educ. 59 ,255 (1982)

Detailed one-step procedure; uses a vacuum distillation. Identification is by preparation of derivatives. Starting material is 6-methyl-5-hepten-2-one.

***ORG PHYS NMR PROJ RADIOCHEM TRACER 4**

Carbon-13 NMR Spectra of Styrene Derivatives: An undergraduate experiment involving the application of the Hammett equation

Blunt, J. W.; Happer, D. A. R.

J. Chem. Educ. 56 ,56 (1979)

NMR of series of substituted styrenes determined as class project and analyzed.

***ORG ANAL QUAL 3 4**

L-Amino Acid Ethyl Ester Hydrochlorides; Derivatives for Qualitative Organic Analysis

Borders, C. L., Jr.; Blech, D. M.; McElvany, K. D.

J. Chem. Educ. 61 ,814 (1984)

Amino acids are used as natural product unknowns for qual. organic, but derivatives are not easily obtained. Directions are given here for conversion of 15 of the 21 common L-amino acids to their ethyl ester hydrochlorides; identification data are given.

***ORG CHIRAL IONX ISOMERS POLARIM PREP RESOLUTION 3 HAZARD**

The Resolution of D,L-Histidine: An organic chemistry experiment using an ion exchange resin

Bosch, A. J.

J. Chem. Educ. 46 ,691 (1969)

D-tartaric acid salts of racemic amines eluted. Weak base ion exchange column. HAZARD: liq. Br₂ used to test for histidine.

***ORG GC GEOM IR ISOMERS NMR PHOTO PREP TLC UVIS 3**

Z- and E- Stereoisomerism: An experiment using photochemistry

Bourelle-Wagnier, F.; Feigenbaum, A.; Muzart, J.

J. Chem. Educ. 55 ,339 (1978)

Prep'n 2-benzylidenecyclohexanone and the photo-rearrangement to the Z-isomer. Differentiate by gc, tlc, nmr, ir, uv. Also behavior of these to epoxidation (Z- much slower).

***ORG COLUMNC ORGANOMETAL PREP 3 HAZARD**

Acetylation of Ferrocene: A chromatography experiment for elementary organic laboratory

Bozak, R. E.

J. Chem. Educ. 43 ,73 (1966)

Acetylation with acetic anhydride-phosphoric acid. Chromatography with alumina using benzene as eluant gives ferrocene and acetylferrocene

Used at RPI and extended to dry column chromatog., and also to forcing conditions to diacetylferrocene, and tlc. HAZARD (avoidable): benzene.

***ORG ADDITION CATAL DIELS,ALDER PHOTO PREP 3 HAZARD**

The Photoaddition of Maleic Anhydride to Benzene: A simple organic experiment in a complicated system

Bozak, R. E.; Alvarez, V. E.
J. Chem. Educ. 47, 589 (1970)

Diels-Alder addition sensitized by benzophenone. Sunlight.

HAZARDS: benzene is carcinogenic; maleic anhydride toxic.

***ORG HETEROCYCLIC MACROCYCLE PREP 3**

Synthesis of Tetraphenylporphyrin: A Convenient Undergraduate Organic Laboratory Experiment

Bozak, R. E.; Hill, C. L.
J. Chem. Educ. 59, 36 (1982)

Short note describes prep. (simple) from pyrrole and benzaldehyde.

See Maitland, M.S. and Langley, R.H., J. Chem. Ed. 61, 566 (1984) for some simple extensions.

***ORG PHYS CATAL LUMIN PHOTO 2 HAZARD**

A Chemiluminescence Demonstration - Oxalyl Chloride Oxidation
Bramwell, F. B.; Goodman, S.; Chandross, E. A.; Kaplan, M.

J. Chem. Educ. 56, 111 (1979)

Oxidation by alumina - 3% H₂O₂ slurry. Color depends on sensitizer.

4 candidates given. Explicit details.

HAZARD: Oxalyl chloride is toxic, a lachrymator and irritant, and reacts violently with water.

***ORG NAME PHOTO PHOTORES PREP REARRANGE UVIS 4 HAZARD**

A Positive Photoresist: The Photochemical Wolff Rearrangement
Bramwell, F. B.; Zhdjura, R. E.; Paley, C.; Fahrenholtz, S. R.

J. Chem. Educ. 55, 403 (1978)

Starting material salt of 1-diazo-1,2-naphthoquinone-5-sulfonate. Ethyl ester (prep'n) mixed with resin, exposed uv. HAZARD: chlorosulfonic acid is corrosive and reacts violently with water.

***ORG PHYS GRIGNARD IR ISOTOPE 3**

An Early Laboratory Introduction to IR Spectroscopy: Gaseous deuterioalkanes
Braun, L. L.; Law, L.

J. Chem. Educ. 58, 79 (1981)

Gaseous propane and propane-1-d prepared from 1-bromopropane by Grignard reaction using tetrahydrofuran as solvent. Construction of inexpensive gas cell from screw cap type condenser cooling jackets described.

***ORG ANAL PREP QUAL SUBST.RXN 3 HAZARD**

A New Method for the Preparation of Derivatives of Carboxylic Acids
Brindle, I. D.; Chassie, S.

J. Chem. Educ. 61, 347 (1984)

The use of anhydrous potassium fluoride (poison) to aid in preparing esters of carboxylic acids in qual. organic analysis is described. A generalized procedure for preparing esters from p-bromobenzyl bromide or p-nitrobenzyl bromide is provided. HAZARD: KF and HF, described.

***ORG NAME NAME PREP 3 HAZARD**

p-Carboxystyrene: A Wittig Procedure in Aqueous Medium

Broos, R.; Thyernier, D.; Anteonis, M.

J. Chem. Educ. 55, 813 (1978)

p-Carboxybenzyl bromide, triphenylphosphine and formaldehyde. HAZARD: formaldehyde is cancer suspect agent.

***ORG ANAL ASPIRIN CONSUMERPROD COURSE PREP PROJ UVIS 2**

The Aspirin Project. Laboratory Experiments for General Chemistry.

Brown, D. B.; Friedman, L. B.

J. Chem. Educ. 50, 214 (1973)

One-semester introductory course for non-science majors, or project for part of a longer course. Involves synthesis from salicylic acid, determination of molecular weight, physical properties, spectroscopic properties, hydrolysis to salicylic acid, and analysis of aspirin tablets.

***ORG PREP PTC REDOX 3**

The Oxidation of Terminal Alkenes by Permanganate: A Practical Demonstration of the Use of Phase Transfer Agents

Brown, K. C.; Chang, V. S.; Dar, F. H.; Lamb, S. E.; Lee, D. G.
J. Chem. Educ. 59, 696 (1982)

Explicit directions for oxidation of eight terminal alkenes (e.g. 1-octene) to the acid (e.g. heptanoic) with aq.- methylene chloride KMnO₄ using Adogen 464 as a PTC.

***ORG GC PREP PROOF 3 4 HAZARD**

Styrene Iodochloride: A proof-of-structure experiment

Buckles, R. E.; Knaack, D. F.

J. Chem. Educ. 37, 298 (1960)

Direction of addition of ICl to styrene studied by analysis of subsequent dehydration and hydration reactions and preparation of derivatives. Could involve nmr. HAZARD: ICl can produce serious burns.

***ORG COLLIG COLOR NATPROD UVIS 1**

Maple Syrup Production as a Laboratory Exercise

Burt, N. E.

J. Chem. Educ. 50,623 (1973)

Vis spectrophotometer can be used for grading color, or a color comparator.

Maple sap.

***ORG CATAL IR ISOMERS PESTICIDE PHOTO PREP TLC 4 HAZARD**

Solid State Photochemical Isomerization: A Convenient Laboratory Experiment

Burton, W. B.

J. Chem. Educ. 56,483 (1979)

Photoisomerization of Dieldrin using germicidal lamps, monitored by tlc on silica gel. Benzophenone is used as the sensitizer. Dieldrin, benzophenone and photodieldrin then separated from reaction mixture by preparative tlc. Examined by ir.

HAZARD: Dieldrin is extremely toxic.

***ORG ORGANOMETAL PHOTO PREP 4**

Sunlight Photochemistry: The Preparation of Dicarboxyl(eta(5)-methylcyclopentadienyl) triphenylphosphinemanganese

Calabro, D. C.; Lichtenberger, D. L.

J. Chem. Educ. 59,686 (1982)

Reaction of tricarbonylmethylcyclopentadienylmanganese with triphenyl phosphine (best in inert atmosphere) followed by recryst. Detailed procedure but no hazard analysis. Suggestions for modification.

***ORG NATPROD PREP SEQ 3 HAZARD**

Conversion of Sucrose Into a Carboxylic Acid: An undergraduate experiment

Carman, R. M.; Evans, R. F.

J. Chem. Educ. 46,847 (1969)

Sucrose is hydrolyzed, the glucose-fructose mixture converted to the osazone, oxidized by copper(II) to the osotriazole, then by permanganate to 2-phenyl-1,2,3-triazole-4-carboxylic acid. HAZARD: phenylhydrazine is toxic.

***ORG ELECTROCHEM TAUTOMERS 3**

Preparative Reduction of Benzil: Use of a Polarographic Analyzer and Simple Current Booster

Carney, J. H.; Mullis, O. J.

J. Chem. Educ. 51,343 (1974)

Requires potentiostat or polarograph plus booster and power supply (schematic given). Reduction to benzoin. Rate of tautomerization of stilbenediol can be obtained.

***ORG KIN PREP SUBST.RXN UVIS 3 HAZARD**

Relative Rates of Electrophilic Aromatic Substitution

Casanova, J., Jr.

J. Chem. Educ. 41,341 (1964)

Rate of bromination in 90% HOAc. HAZARD: bromine.

***ORG GAS PREP 3**

Student Preparation and Manipulation of a Gas: Methyl Ethyl Ether

Casanova, J., Jr.

J. Chem. Educ. 40,41 (1963)

Test tube setup. No vac. rack. Ice-brine baths. Sodium methoxide - ethyl iodide reaction. B. pt., but no other properties measured.

***ORG ANAL ACBA DEMO NATPROD PROJ 1 2**

Grape Juice as an Indicator

Castka, J. F.

J. Chem. Educ. 39,A43 (1962)

Can be a student project - try oxidizing and reducing agents as well as various acids and bases - pH measured? Other plant colors. A Chem Ed Tested Demo.

***ORG ISOMERS PHOTO PREP 2 3**

The Photochemical Isomerization of Maleic to Fumaric Acid

Castro, A. J.; Ellenberger, S. R.; Sluka, J. P.

J. Chem. Educ. 60,521 (1983)

Maleic acid in water, with added trace of bromine, is irradiated by sunlamp or direct sunlight for 15-20 min. Crystals of fumaric acid are deposited and collected, and the m.pt. determined. Photoisomerization of the methyl esters was given as a Tested Demo earlier (Dutton, F.B., J. Chem. Ed. 38, A17 (1961). CAUTION: minimize exposure to UV radiation. See also a letter (J. Chem. Ed., 61, 565 (1984) by these authors.

***ORG IR NMR PHEROMONES PREP SEQ 4**

Preparation of Propyl N,N-Diethylsuccinamate: An Insect Repellent

Caudle, R.; Siegel, G.; Wood, W. F.

J. Chem. Educ. 59,1069(1982)

Detailed preparation from succinic anhydride, SOCl₂, diethyl amine.

Hazards are identified in the article. Identification by NMR, IR.

***ORG NOPROC QUAL SEQ 3**

The Preparation, Oxidation and Characterization of an Unknown Secondary Alcohol

Chittum, J. W.; Haynes, L. W.

J. Chem. Educ. 51,57 (1974)

Short note describes 3-lab period exp't where various combinations are issued for (a) formation of a Grignard reagent from an alkyl halide, (b) reaction with an aldehyde, (c) purification, then oxidation to a ketone. Identification by preparation of solid derivatives (or ir plus nmr).

***ORG CYCLOADDITION GRIGNARD IR PREP SEQ 4 HAZARD**

Preparation of 2,3-Diphenyl-1-Indenone and Related Compounds

Clark, T. J.

J. Chem. Educ. 48,554 (1971)

Requires benzaldehyde; Grignard reaction gives title cpd. Hydrogen peroxide epoxidation followed by reaction with methyl acetylenedicarboxylate (caution: irritant) gives dipolar addition. Detailed directions.

HAZARD (avoidable): benzene - carcinogen.

***ORG NAME PREP 3**

A Synthesis of o-Chlorocinnamic Acid Utilizing a Meerwein Reaction: An undergraduate organic experiment

Cleland, G. H.

J. Chem. Educ. 55,814 (1978)

o-Chloroaniline is diazotized and reacted via a Meerwein reaction with acrylic acid to produce alpha-bromo-o-chlorohydrocinnamic acid. Explicit procedure. Caution: eye and respiratory irritant may be produced in a side reaction.

***ORG PHOTO PREP 3**

Photochlorination of Hydrocarbons with Chlorine Generated in Situ

Condon, F. E.; Sokoloff, M.

J. Chem. Educ. 36,554 (1959)

Fair yields of chlorocyclohexane have been obtained by irradiating a mixture of cyclohexane, conc. HCl and MnO₂. No details or procedure. Caution: Cl₂ is generated.

***ORG PHYS DEMO FREERAD GAS PHOTO 1 2 HAZARD**

Free Radical Chlorination of Methane:

A Demonstration

Conklin, A. R.; Kramme, A.

J. Chem. Educ. 60,597 (1983)

Photochlorination of methane in natural gas is used to demonstrate free radical reactions. GC used to analyze reaction products. UV light, hood and oxygen-free atmosphere are needed. HAZARD: Cl₂ is a strong oxidant & irritant. Prolonged exposure can cause pulmonary edema.

***ORG PHYS KIN PREP 3**

Alcohols to Alkyl Halides: A kinetics experiment for elementary chemistry courses

Cooley, J. H.; McCown, J. D.; Shill, R. M.

J. Chem. Educ. 44,280 (1967)

Rates followed by direct observation of change in volume of insoluble layer formed in reaction of ROH, HBr, and H₂SO₄, R = primary and secondary four and five carbon alcohols. Can be used in conjunction with small scale preparation.

***ORG GRIGNARD NATPROD PHEROMONES PREP PROJ SEQ 3**

Laboratory Syntheses of Insect Pheromones

Cormier, R. A.; Hoban, J. N.

J. Chem. Educ. 61,927 (1984)

A four step sequence of reactions requiring one lab period each to prepare 4-methylheptadecane, the tiger moth sex attractant, from palmitic acid. The steps are suitable and illustrative of reactions encountered by introductory organic students. Reduction by Fieser's (in situ) method. A brief discussion with references for a more advanced synthesis of boll weevil pheromones is also given.

***ORG IR NAME NMR PHEROMONES PREP TLC 4**

A Student Synthesis of The Housefly Sex Attractant

Cormier, R. H.; Phan, M. D.; Graddis, T.; Singer, R.

J. Chem. Educ. 56,345 (1979)

Erucic acid is converted to acid chloride, which reacts with ethoxymagnesium malonate to form ketone. Prep'n of semicarbazone and Wolf Kishner reduction gives Z-9-tricosene. Caution: care should be exercised since it appears to be absorbed into the skin, thereby making the host attractive to male house flies for long periods.

*ORG INORG CATAL GC PREP 3

Cyclohexanol Dehydration: A Simple Experiment in Heterogeneous Catalysis
Costa, A.

J. Chem. Educ. 59,1066(1982)

High-yield dehydration of cyclohexanol on gamma-alumina at 300 C yields a mixture of cycloolefins analyzable by GC. Schematic diagram of flow reactor and identification of hazards given; extensions suggested.

*ORG PREP SUBST.RXN 3 HAZARD

Experiments With Electrophilic Aromatic Substitution Reactions

Cox, B.; Kubler, D. G.; Wilson, C. A.

J. Chem. Educ. 54,379 (1977)

Prep'n of 1,4-dibromobenzene, 1,2,4,5-tetrabromobenzene, nitrobenzene by optimizing simple conditions. HAZARDS: liquid bromine, benzene.

*ORG DTA QUAL 3

Preparation of Solid Derivatives by Differential Scanning Calorimetry

Crandall, E. W.; Pennington, M.

J. Chem. Educ. 57,824 (1980)

Microscale prep. of derivatives for identification, in most cases by mixing drops of reagents on sample pan, sealing and heating. In a few cases, preliminary mixing and evaporation is necessary. DSC then gives mp.

*ORG APPARATUS PREP 3 HAZARD

Enamine Reactions For The Undergraduate Organic Laboratory: A student water separator

Darling, S. D.

J. Chem. Educ. 43,665 (1966)

Making a Dean-Stark water trap is described (hard to follow). Used to make enamine by azeotrope with benzene (HAZARD: substitute toluene) in 1.5 hr. Suggestions for alkylations, acylations.

*ORG ANAL REDOX TLC 1 2 HAZARD

Using TLC to Follow the Oxidation of a Secondary Alcohol to a Ketone
Davis, M.

J. Chem. Educ. 45,192 (1968)

Borneol oxidized to camphor by CrO₃-H₂SO₄ (dil), semi-micro. Progress reaction followed TLC. HAZARD: CrO₃ is carcinogenic. (Here it could be handled safely, as long as powder not inhaled.)

*ORG DEMO GC 3

The Nitration of Alkylbenzenes: A Lecture Demonstration

Davis, M.; Deady, L. W.; Paproth, T. G.

J. Chem. Educ. 55,34 (1978)

Toluene and t-butylbenzene are each nitrated (test tube scale) and products extracted with ether. Solution is injected into glc. Explicit details.

*ORG COLUMNC NAME PHOTO PREP SEQ UVIS 4 HAZARD

The Preparation and Photochemistry of Stilbenes: A synthetic organic chemistry experiment

Davy, J. R.; Jessup, P. J.; Reiss, J. A.

J. Chem. Educ. 52,747 (1975)

Multistep synthesis - 4 periods. NBS bromination of p-xylene, followed by reaction with triphenylphosphine. Wittig reaction with p-tolualdehyde requires methyl lithium. Photochemical isomerization of dimethylstilbene to dimethylphenanthrene requires Hg arc lamp, column chromatog.; follow by uv. HAZARDS: benzoyl peroxide, lachrymatory product; lithium metal; Hg arc lamp.

*ORG APPARATUS COLOR QUAL 3

Spot Test for Azo Dye Formation: An Undergraduate Laboratory Experiment

DeGroot, R. A. M. C.; Neumann, M. G.

J. Chem. Educ. 56,625 (1979)

Drawing of a device for reproducible spot tests given. Reagents are p-nitrobenzenediazonium chloride and the sodium salt of 1-amino-8-naphthol-3,6-disulfonic acid (H-salt). The spot test is based on the lower solubility and migration rate of the dye compared with the coupling agent or the diazonium salt, and shows if an excess of either is present.

*ORG PREP SEQ 4 HAZARD

Preparation of The Sweetening Agent P4000: A student project

DeKoning, A. J.

J. Chem. Educ. 53,521 (1976)

1-Chloro-2,4-dinitrobenzene reacts to form 1-n-propoxy-2,4-dinitrobenzene. Partial reduction gives a mixture of isomers which is separated by basicity. Product is 1-propoxy-2-amino-4-nitrobenzene. HAZARD: 2,4-dinitrochlorobenzene is toxic and a bad vesicant, and product is a cancer-suspect agent. See also Idoux, this file (1972). NOTE: Woollard, J. McK., J. Chem. Ed. 57, 464 (1980), reports column chromatog. to separate the two isomeric products.

*ORG CATAL GC IONX NAME NMR PREP TLC 4

An Easy Student Synthesis of a Substituted 1,3-Dioxane by Use of an Ion-Exchange Resin as a Catalyst: Clean Illustration of the Prins Reaction
Delmas, M.; Kalck, P.; Gorrichon, J. P.; Gaset, A.
J. Chem. Educ. 59,700 (1982)
Isoeugenol is condensed with paraformaldehyde in the presence of a small amount of a cation exchanger in an original synthesis of a 1,3-dioxane. Identification (IR, NMR, etc.) parameters given. About 2 lab periods.

*ORG HETEROCYCLIC PREP SEQ 3

Synthesis of Cyclopentanecarboxaldehyde: An undergraduate organic chemistry experiment
Dev, V.
J. Chem. Educ. 47,476 (1970)
Rx seq. begins by treating cyclohexene oxide (from cyclohexene) w. magnesium bromide etherate; then ring opening to the trans diol, and pinacol rearrangement gives product. 11 cyclo- and heterocyclics in the sequence.

*ORG PHYS ISOMERS KIN UVIS 3

Acid and Base Catalyzed Isomerization of delta-5-cholesten-3-one: An experiment in UV/kinetics
Dimmel, D. R.; McKinney, M. A.
J. Chem. Educ. 49,373 (1972)
Beckman DU. The isomerization is to delta-4-cholesten-3-one. Both isomers available commercially.

*ORG DEMO FREERAD ISOMERS KIN OPTICAL PHOTO 3

The Effect of Free Radical Stability on the Rate of Bromination of Hydrocarbons
Doheny, A. J.; Loudon, G. M.
J. Chem. Educ. 57,507 (1980)
Tested demonstration. Overhead projector used to show relative rates of free radical (Br atoms) photobromination of benzene, toluene, ethylbenzene, cumene, tert-butylbenzene in CCl₄ sol'n. Caution: benzene, CCl₄, Br₂ toxic. HBr gas evolved.

*ORG NATPROD NOPROC PREP SEQ 4

Alpha-Pinene, A Starting Material For a Sequence of Organic Experiments
Dominguez, X. A.; Leal, G.
J. Chem. Educ. 40,347 (1963)
Alpha-pinene distilled from turpentine is converted to bornyl chloride, camphene, isobornyl acetate, isoborneol, camphor and others. HAZARD: assorted dangerous reagents are involved, e.g., chromic acid and nitrosyl chloride are cancer suspect agents.

*ORG DIELS.ALDER NMR PHOTO PREP SEQ 4

An Easy Synthesis of Two Cage Hydrocarbons
Dong, D. C.
J. Chem. Educ. 59,704 (1982)
3-Step synthesis of two birdcage hydrocarbons. Starting material is hexachloronorbornadiene. Diels-Alder reaction, photocyclization followed by removal of the halogen with lithium metal. Complete hazard analysis, complete directions, and excellent study questions.

*ORG DRYLAB NMR PROOF 3

Interpretation of a C-13 Magnetic Resonance Spectrum
Dorn, H. C.; Kingston, D. G. I.; Simpers, B. R.
J. Chem. Educ. 53,584 (1976)
Exercise in deduction of a structure from proton and C-13 nmr spectra of bis(2-ethylhexyl)phthalate.

*ORG QUAL 4

The Sodium Nitroprusside Reagent II - A Solvent Modification
Dougherty, C. M.; Baumgarten, R. L.; Markowska, M.; Battey, Y. C.
J. Chem. Educ. 55,341 (1978)
A mixture of 60% tetrahydrofuran/20% ethanol/20% H₂O can be used to replace DMSO as a solvent for sodium nitroprusside in testing for aliphatic and aromatic amines. Colors developed when this solvent is used are given.

*ORG NAME PREP SEQ 3

Phthalimide, Anthranilic Acid, Benzyne: An undergraduate organic laboratory sequence.
Dougherty, C. M.; Baumgarten, R. L.; Sweeny, A.; Concepcion, E.
J. Chem. Educ. 54,643 (1977)
Explicit directions. Requires tetraphenylcyclopentadienone.

*ORG NMR TAUTOMERS 4 HAZARD

An NMR Study of Keto-Enol Tautomerism in Beta-dicarbonyl Compounds
Drexler, E. J.; Field, K. W.
J. Chem. Educ. 53,392 (1976)
Data for 6 candidate compounds given. Study solvent and temperature effects (variable temperature probe). HAZARD (avoidable): CCl₄ is carcinogenic.

***ORG CHIRAL GEOM ISOMERS NATPROD POLARIM PREP 3 HAZARD**

The Stereochemistry of (-) Menthol: An organic laboratory experiment

Dunathan, H. C.

J. Chem. Educ. 40, 205 (1963)

(-) menthone, from oxidation of (-) menthol, is treated with acid and mutarotation followed. Reduction of (-) menthone to (+) neomenthone with NaBH₄. HAZARD: chromic acid is a cancer suspect agent.

***ORG FRIEDEL.CRAFTS GC IR ISOMERS PREP 3 HAZARD**

The Friedel-Crafts Alkylation of Benzene: A first-year organic laboratory experiment

Dunathan, H. C.

J. Chem. Educ. 41, 278 (1964)

Isomeric butyl chlorides react to give different alkylated benzenes.

Products investigated by gc and quantitative ir.

HAZARD (avoidable): benzene.

***ORG NMR PREP 3**

NMR Structure Identification of N-(1,1,3,3-Tetramethylbutyl)formamide

Dunn, H. E.; Fairless, B. J.

J. Chem. Educ. 49, 512 (1972)

Prep'n of title compound from N-(1,1,3,3-tetramethylbutyl)amine + formic acid. Identification requires solvent changes, decoupling and temperature variation to make a complete assignment. Reader (DT) suggests title cmpd should be 2-formylamino-2,4,4-trimethylpentane.

***ORG ANAL PTC QUAL 3**

A Classification Test For Aldehydes Involving Phase Transfer Catalysis

Durst, H. D.; Gokel, G. H.

J. Chem. Educ. 55, 206 (1978)

Not a student experiment but an improved qual. organic anal. test using 4-amino-3-hydrazino-5-mercaptop-1,2,4-triazole.

***ORG PHYS DEMO KIN REDOX 1**

Methylene Blue: Reduction and Oxidation

Dutton, F. B.

J. Chem. Educ. 37, A79 (1960)

Reduction of methylene blue by alkaline dextrose solution; reoxidation (when shaken) with air. A Chem-Ed Tested Demo.

***ORG DEMO ISOMERS PHOTO 3**

Cis-Trans Isomerization

Dutton, F. B.

J. Chem. Educ. 38, A17 (1961)

Dimethyl maleate converted to dimethyl fumarate in the presence of H₂SO₄, heat and light. A Chem-Ed Tested Demo. See also Castro, A. J., Ellenberger, S. R., and Sluka, J. P., J. Chem. Ed., 60, 521 (1983) for isomerization experiment using maleic acid.

***ORG DEMO PREP 3**

Synthesis of Dimethyl Maleate

Dutton, F. B.

J. Chem. Educ. 38, A17 (1961)

From maleic anhydride, methyl alcohol and H₂SO₄. Distillation, washing, and drying procedures are demonstrated. (The preparation takes 2 hours.) A Chem-Ed Tested Demo. Warning: maleic anhydride - toxic.

***ORG GC GRIGNARD MISTAKE PREP 3**

Grignard Dehydration Reactions

Duty, R. C.; Ryder, B. L.

J. Chem. Educ. 53, 457 (1976)

Prep of 2,3-dimethyl-2-butanol from 2-bromopropane and dehydration to isomeric 2,3-dimethyl-2-butene and 2,3-dimethyl-1-butene. (Error in structural formula). Analysis by GC. 2 lab. periods.

***ORG PHYS IR NAME SUBST.RXN 4 HAZARD**

An Experiment in Activated Aromatic Nucleophilic Substitution

Dyall, L. K.

J. Chem. Educ. 43, 663 (1966)

Aromatic nucleophilic substitution on picryl compounds. Meisenheimer intermediates. HAZARDS: picryl compounds are explosives, CHCl₃ is carcinogenic.

***ORG IR PREP 3**

Benzoxazinone Syntheses: An organic chemistry experiment

Eckroth, D. R.

J. Chem. Educ. 49, 66 (1972)

Five different compounds, some commercially available, some interconvertible, are each converted into one product, 2-methyl-4H-3,1-benzoxazin-4-one. Chemistry is sketchy and not typical.

***ORG DEMO SEPARATION 1 2**

Separation of a Mixture

Eddy, R. D.

J. Chem. Educ. 36 ,A37 (1959)

A Chem-Ed Tested Demo. Sugar + C + CaCO₃.

***ORG PHYS CLATH DEMO 1 HAZARD**

Quinol-H₂S Clathrate Compound

Edwards, T. F.

J. Chem. Educ. 35 ,A48 (1958)

Hydroquinone inclusion compound. A Chem-Ed Tested Demo. HAZARD: H₂S is a nerve poison.

***ORG GRIGNARD NAME NATPROD PHEROMONES PREP 3**

The Synthesis of 4-Methyl-3-heptanol and 4-Methyl-3-heptanone: Two Easily Synthesized Insect Pheromones.

Einterz, R. M.; Ponder, J. W.; Lenox, R. S.

J. Chem. Educ. 54 ,382 (1977)

Starting reagents are 1-propanal and 2-bromopentane. Simple apparatus.

The ketone is produced by dichromate oxidation of the alcohol. Separation

of diastereomers by gc possible. See later correction: Hoffman, R. V., et

al, J. Chem. Educ.,60, 78 (1983).

***ORG PREP 2 3**

The Last (?) Word on Student Preparation of Benzalacetophenone

Elern, J. E.

J. Chem. Educ. 56 ,418 (1979)

Simple preparation.

***ORG GRIGNARD IR MASSPEC NMR NOPROC PREP 3**

The Preparation and Spectral Analysis of Toluene-Alpha-D

Ellis, J. W.; Buchanan, D. H.

J. Chem. Educ. 52 ,265 (1975)

Grignard from benzyl chloride is quenched with D₂O.

***ORG ANAL DEMO DISTRIB PHASE TECHNIQUE UVIS 2**

A Simple Extraction Experiment

Ellis, L. N.; Fox, M.

J. Chem. Educ. 37 ,510 (1960)

Salicylic acid / n-Butyl Acetate. Vis. spectrophotometer to analyze

salicylic acid by color with FeCl₃. Colorimetric method used by students.

Calc. dist. coeff. Designed to illustrate technique of extraction.

***ORG FRIEDEL.CRAFTS NAME PREP 3**

Preparation of Diphenylmethane

Ellis, W. D.

J. Chem. Educ. 40 ,346 (1963)

Modified procedures for Friedel-Crafts alkylation gives better yields, fewer impurities.

***ORG IR NATPROD PREP SEQ 3 HAZARD**

The Preparation and Isomerization of Allyl Thiocyanate: An organic chemistry experiment

Emerson, D. W.

J. Chem. Educ. 48 ,81 (1971)

Reaction sequence: allyl bromide to thiosulfate to thiocyanate by reaction with cyanide. Allylic rearrangement to alkyl isothiocyanates.

HAZARDS: cyanide, irritants (garlic and horseradish odors).

***ORG LUMIN PREP 3**

N-Acetylanthranilic Acid: A Highly Triboluminescent Material

Erikson, J.

J. Chem. Educ. 49 ,688 (1972)

Explicit directions for prep'n, from anthranilic acid, acetic anhydride.

***ORG ANAL BIOCHEM PREP UVIS 3**

1,4-Dihydro-3,5-Diacetyl Lutidine: A Basis for Triglyceride

Determination in Biological samples

Erikson, J. M.; Biggs, H. G.

J. Chem. Educ. 50 ,631 (1973)

1,4-Dihydro-3,5-diacetyl lutidine synthesized from pentanedione, NH₃ and formaldehyde and also by periodate oxidation of glycerol obtained from ester exchange with lipid in biological assay, and determined by UV spectrophotometry, 277 nm. Corn oil or olive oil standard.

Unknowns: serum or milk. Explicit procedure. Designed for pre-meds.

***ORG COLUMNC PHOTO PREP TLC 3 HAZARD**

The Cyclodehydrogenation of Azobenzene: A photochemical experiment for an undergraduate organic course

Evans, R. F.

J. Chem. Educ. 48 ,768 (1971)

Window light isomerizes protonated trans-azobenzene to benzo(c)innoline and benzidine. Separations are not simple. HAZARDS: one product (benzidine) is a potent carcinogen; benzene is also a carcinogen.

***ORG GC IR NMR PREP REARRANGE 3 HAZARD**

A Series of Related Organic Experiments with Optional Structure Determinations

Fairless, B. J.; Ragsdale, G.; Kerby, C.
J. Chem. Educ. 51, 61 (1974)

Prep. of allyl phenyl ether gives mix of products when strong base is used. Separate (partially) by distillation, then prep. gc. Thermal rearrangement of allyl phenyl ether, acid catalyzed rearrangement of 2-allylphenol.

***ORG IR PREP SUBST.RXN TAUTOMERS 3**

An Experiment to Illustrate Nucleophilic Aromatic Substitution And Tautomerism

Farmer, J. L.; Haws, E. J.
J. Chem. Educ. 47, 41 (1970)

2-Chloropyridine is hydrolyzed easily. IR shows tautomerism.

***ORG ANAL DEMO QUAL 3**

Spot Reaction Experiments

Feigl, F.
J. Chem. Educ. 34, 457 (1957)

A new series of semimicro reactions for organic analysis and teaching organic chemistry. Pyrolysis of organic compounds w. KNO_3 , reduction of nitric acid w. benzoyl peroxide; SO_2 from thiourea and thioglycolic acids by reaction w. benzoyl peroxide. Spot test used for detection of reaction products, HNO_2 and SO_2 . Suitable for demonstration purposes.

***ORG IR PREP SUBST.RXN 3 HAZARD**

Substituent Effects on Aromatic Electrophilic Substitution: An "experimental" class exercise

Ferguson, P. R.
J. Chem. Educ. 48, 405 (1971)

A first experiment in organic chemistry. Bromination of substituted benzenes; class data on yields, direction and extent of substitution to draw conclusions. HAZARD: benzene is carcinogen, could be omitted.

***ORG MACROCYCLE PREP PTC 3 HAZARD**

"Crown Ether" Synthesis: An organic Laboratory Experiment

Field, K. W.; Glover, A. D.; Moroz, J. S.; Collander, D. J.; Kolb, K. E.
J. Chem. Educ. 56, 269 (1979)

Preparation of a furan-acetone macrocyclic polyether by a one-step, two-lab period synthesis. Common lab reagents and techniques. Applications to PTC noted. Information for preparation of macrocycles of furan and other ketones given. HAZARD: Crown ethers (at least some) are toxic. See Glidewell, C., J. Chem. Educ. 57, 236 (1980) for an improvement in rate.

***ORG NATPROD PREP TLC 2**

Trimyristin From Nutmeg

Frank, F.; Roberts, T.; Snell, J.; Yates, C.; Collins, J.
J. Chem. Educ. 48, 255 (1971)

Crushed nutmegs are extracted and trimyristin saponified to myristic acid. Used in 'honors' gen. chem. at RPI. 1 lab period. Caution: ether extraction

***ORG PHYS DEMO LUMIN REDOX 2 3**

A Simplified Chemiluminescence Demonstration Using Luminol and Hypochlorite Bleach

Fuchsman, W. H.; Young, W. G.
J. Chem. Educ. 53, 548 (1976)

Fail-safe method for chemiluminescence from oxidation of luminol with Chlorox.

***ORG GC ISOMERS NOPROC 3**

A Laboratory Study of Steric and Inductive Effects

Fulkrod, J. E.
J. Chem. Educ. 51, 115 (1974)

Nitration of different alkylbenzenes followed by gc. Results from many students pooled for discussion. Extensions.

***ORG PREP REDOX 3**

Steam Distillation of Essential Oils -- Anethole from Anise Followed by Permanganate Oxidation to Anisic Acid

Garin, D. L.
J. Chem. Educ. 57, 138 (1980)

Note gives full description.

***ORG PREP PROJ PROOF 3**

Indene Reactions: An organic chemistry laboratory problem

Garrison, J. A.
J. Chem. Educ. 47, 300 (1970)

Prob. is what is structure of indene bromhydrin, prepared by reacting indene with Br_2 in KBr . This can be converted to the epoxide, or reduced (Raney nickel + $\text{Mg}(\text{OH})_2$) to 1-indanol. Hydroboration of indene gives isomeric indanol. Do not let students read.

***ORG CONDUCT KIN NOPROC PREP PROJ 4**

The Synthesis and Methanolysis of Benzyl Tosylates; An Advanced Organic Chemistry Experiment

Garst, M. E.; Gribble, G. W.
J. Chem. Educ. 61,819 (1984)

Individual students synthesize three different tosylates and determine rates of SN1 solvolysis at three different temperatures using conductance techniques. Suggestions for the tosylate preparations are discussed and references provided. A possible report format is suggested. Requires 12-16 three hour labs.

***ORG COLUMNC PREP 3 4 HAZARD**

The Synthesis of 4,6,8-Trimethylazulene

Garst, M. E.; Hochlowski, J.; Douglass, J. G., III; Sasse, S.
J. Chem. Educ. 60,510 (1983)

The two-step synthesis and purif. require two periods. Trimethylpyrylium fluoroborate is prepared from fluoroboric acid (HAZARD: corrosive, toxic), t-butyl alcohol and acetic anhydride. Cyclopentadiene (from distillation-cracking of the dimer) is treated with sodium methoxide (HAZARD: may ignite in moist air, and explosively with water) in dimethylformamide. Addn. of the pyrylium salt gives the azulene, isolated by pet. ether extrn. and chromatog.

***ORG POLYMER CATAL PREP TECHNIQUE 3**

Uses of a Vinylpyridine Polymer in Undergraduate Organic Syntheses
Getman, D.; Hagerty, D.; Wilson, G.; Wood, W. F.

J. Chem. Educ. 61,550 (1984)

The use of the title compound in place of pyridine is convenient and avoids toxicity problems. Three examples are described: esterification of cyclohexanol with 3,5-dinitrobenzoyl chloride, as catalyst in the Knoevenagel reaction of benzaldehyde and malonic acid, and in the bromination of E-cinnamic acid.

***ORG NAME PREP 3**

Oxymercuration-Demercuration: An Organic Experiment Involving The Markovnikov Hydration of Olefins

Gibbs, R.; Weber, W. P.
J. Chem. Educ. 48,477 (1971)

1-hexene, 1-octene, styrene, etc. yields the secondary alkanols.
Caution: mercury salts are toxic.

***ORG GEOM NAME NOPROC PREP PROJ PTC 3**

Diphenylbutadienes Syntheses by Means of the Wittig Reaction:

Experimental introduction to the use of phase transfer catalysis

Gillois, J.; Guillermin, G.; Savignac, M.; Stephan, E.; Vo-Quang, L.
J. Chem. Educ. 57,161 (1980)

A student project offering many variations of the Wittig-Horner synthesis of 1,4-diphenylbutadienes. Use of PTC in aqueous-organic media is a variant. IR, UV, nmr used to analyze products.

***ORG PHARM PREP PROJ 3**

Synthesis of Some Unreported Derivatives of Sulfonamides

Gilow, H.

J. Chem. Educ. 56,419 (1979)

Preparation of N(4)-benzylsulfanilamide (an antibacterial agent) by reaction of sulfanilamide with benzaldehyde, plus an extension of this general method for synthesis of other N(4)-substituted sulfonamides.

Students must prepare a compound and check Chem. Abst. to see if the compound is previously reported.

***ORG PHYS GC ISOMERS KIN PREP SUBST.RXN 3 HAZARD**

Substituent Effects in Electrophilic Aromatic Substitution: A laboratory in organic chemistry.

Gilow, H.

J. Chem. Educ. 54,450 (1977)

The acid catalyzed bromination of aromatic substrates with hypobromous acid. General procedure for 10 suitable substrates given. Relative rates by competitive bromination. Product and isomer distribution by quantitative gc (detailed instructions). Open-ended.

HAZARD: Dioxane is a carcinogen.

***ORG PREP REDOX 3 HAZARD**

The Oxidation of Primary Alcohols to Aldehydes With Pyridinium Chlorochromate

Glaros, G.

J. Chem. Educ. 55,410 (1978)

Safe and clean procedure. Reports successful classroom usage. HAZARD: chromium(VI) compounds are cancer suspect agents.

***ORG FRIEDEL.CRAFTS NAME NMR NOPROC PREP SEQ 3 4**

An Integrated NMR and Synthetic Organic Chemistry Experiment

Glaros, G.; Cromwell, N. H.

J. Chem. Educ. 46,854 (1969)

Procedures by lit. reference. Includes Friedel-Crafts alkylation, Willgerodt reaction, Claisen-Schmidt, and radical bromination.

***ORG GEOM ISOMERS NAME NMR PHOTO 3**

An Integrated NMR and Photochemical Organic Chemistry Experiment
Glaros, G.; Cromwell, N. H.

J. Chem. Educ. 48,204 (1971)

NMR spectrum of product of Claisen-Schmidt condensation of 4,4-dimethyl-1-tetralone with benzaldehyde, and its isomerization product when UV irradiated: Z- and E-2-benzal-4,4-dimethyl-1-tetralone.

***ORG NMR 3**

Experiments in NMR

Glaros, G.; Cromwell, N. H.

J. Chem. Educ. 48,202 (1971)

NMR spectra of methanol, methylamine hydrochloride, etc., examined and explained. Rapid proton exchange in methanol is slowed by add'n of acetone and rapid proton exchange in methylamine hydrochloride is slowed by addition of HCl.

***ORG MACROCYCLE MASSPEC NMR PREP 3**

Tetraoxaquaterene Synthesis

Glidewell, C.

J. Chem. Educ. 57,236 (1980)

Extensive modification of an earlier prep. to determine structure by proton and ¹³C nmr and mass spectroscopy, and to show ligand template and time effects on yield.

***ORG ANAL IR NAME NMR PREP 3**

Esters of Some Phosphorus Acids: A Laboratory Experiment

Glidewell, C.; Pogorzelec, P. J.

J. Chem. Educ. 57,740 (1980)

Prep. of dimethylphosphonate, (CH₃O)₂POH, and N-benzyl-O,O-dimethylphosphoramidate (Arbuzov reaction). Vacuum distillation. Requires two or three 3 hr periods. Students identify products from ir and pmr spectra.

***ORG CARBENE PREP PTC 3 HAZARD**

Dihalocarbene Insertion Experiment

Goh, S. H.

J. Chem. Educ. 52,399 (1975)

Insertion of dichlorocarbene into alpha CH bond of diisopropyl ether using a tetraalkylammonium salt as a phase-transfer catalyst. Identification parameters given. Extensions to bromoform, other substrates. HAZARDS: carbon monoxide evolution; chloroform, carcinogen; isopropyl ether forms explosive peroxide on storage. See Weber, W.P., J. Chem. Ed. 51, 216 (1974).

***ORG CARBENE CYCLOADDITION PREP PTC 3 HAZARD**

Dihalocarbene Addition Reaction: An undergraduate laboratory experiment
Goh, S. H.

J. Chem. Educ. 50,678 (1973)

Addition of CCl₂ group to cyclohexene using a tetraalkylammonium salt (suggested: Benzyltrimethylammonium chloride) as phase transfer catalyst. Carbene from chloroform (HAZARD) and base. See also Ault, A.; Wright, B., J. CHEM. EDUC., 53, 489 (1976) for an improved procedure.

***ORG INORG ORGANOMETAL POLARIM PREP RESOLUTION SEQ 4 HAZARD**

Preparation and Resolution of N,N-Dimethyl-Alpha-Ferrocenylethylamine

Gokel, G. W.; Ugi, I. K.

J. Chem. Educ. 49,294 (1972)

Ferrocene start for sequence leading to product, resolved w. (+) tartaric acid salt. Advanced. HAZARD (avoidable): benzene (carcinogen).

***ORG NMR PREP 3 HAZARD**

The Ring-Inversion Barrier of 5,5-Dimethyl-1,3-Dioxane: An Introduction to Dynamic NMR

Greenberg, A.

J. Chem. Educ. 49,575 (1972)

Compound prepared from paraformaldehyde and 2,2-dimethyl-1,3-propanediol. Fluorotrichlorosilane required. HAZARD: benzene solvent, use a substitute.

***ORG DISTRIB NATPROD SEPARATION 3**

Natural Products Isolation - Orange Oil: An undergraduate organic experiment

Greenberg, F. H.

J. Chem. Educ. 45,537 (1968)

Limonene is major component of oil isolated by steam dist. and extraction. Characterization by nmr, ir, gc, refractive index.

***ORG NMR PREP VITAMIN 3 4**

The Reaction of Vitamin K-3 With Sodium Bisulfite: An undergraduate organic experiment

Greenberg, F. H.; Leung, K. K.; Leung, M.

J. Chem. Educ. 48,632 (1971)

2-Methyl-1,4 naphthoquinone gives two different 1,4-addition products, controlled (thermo. and kinetic) by conditions. NMR differentiates.

***ORG CATAL FRIEDEL-CRAFTS PREP REDOX SEQ 3**

The Synthesis of 2-Acetyl-1,4-Naphthoquinone: A Multi-Step Synthesis
Green, I. R.

J. Chem. Educ. 59,698 (1982)

This article is notable for the use of the word "synthon" meaning an isolated intermediate. Four pathways, two starting from 1-naphthol, and two from 1,4-naphthoquinone. Good hazard analysis. Much procedure by lit. ref.

***ORG PHYS NMR 3**

Group Electronegativity by NMR

Greever, J. C.

J. Chem. Educ. 55,538 (1978)

Compounds used are 1-X-propane, where X = chloro, bromo, iodo, amino, nitro, and hydroxy. Explicit procedure.

***ORG APPARATUS DEMO PROJ TECHNIQUE 3**

Zone Refining

Greve, R.

J. Chem. Educ. 40, A40 (1963)

Simply constructed apparatus for zone melting (refining) of naphthalene. A Chem Ed Tested Demo, suitable for a project.

***ORG NATPROD NOPROC 2 3**

Natural Products: An independent study project

Griffin, R. W., Jr.

J. Chem. Educ. 51,601 (1974)

Extraction of alkaloids, terpenes, flavonoids requires 3-10 kg. plant material per student. Mostly ideas, little detail.

***ORG ANAL ACBA NOPROC PROJ 3**

Identification of an Unknown Ester: An analytical-organic experiment

Grob, R. L.; Husk, G. R.

J. Chem. Educ. 46,769 (1969)

Unknown esters given students with minimal directions to hydrolyze and identify alcohol and acid. Directions for two alkyl benzoates given.

Don't let students read it. 15 hrs. lab time.

***ORG PREP 3 HAZARD**

A Modification and Extension of an Elementary Preparation of Ninhydrin
Gruen, H.; Norcross, B. E.

J. Chem. Educ. 42,268 (1965)

A modification of a prep. in Fieser, Exp'ts in Org. Chem. uses sodium hydride instead of powdered sodium, and produces an interesting side product. HAZARD: ninhydrin is a known carcinogen.

***ORG COLOR NMR SEQ 3**

Synthesis of a Photochromic Benzothiazolinic Spiropyran

Guglielmetti, R.; Meyer, R.; Dupuy, C.

J. Chem. Educ. 50,413 (1973)

Three steps, three periods. Caution: chloroform (solvent) is carcinogen; substitute.

***ORG GC ISOMERS NOPROC PHOTO 4**

The Photoisomerization of Cyclic Ketones: An experiment in organic chemistry

Haas, J. W., Jr.

J. Chem. Educ. 51,346 (1974)

Photochemical reactor, 254nm. Cyclopentanone, cyclohexanone, 2-methyl-cyclohexanone give a variety of photolysis products, analyzed by gc.

***ORG COLUMNC DISTRIB IR NATPROD TECHNIQUE TLC 3**

Separation Experiments With Fatty Acids

Hamilton, R. J.

J. Chem. Educ. 55,678 (1978)

Transesterification of castor oil gives methyl esters, separated by column chrom., checked TLC. Saponification gives fatty acids, separated by methanol-water partitioning, esterified, and analyzed TLC and ir.

***ORG ANAL GC REDOX 3**

Oxidation of Fats: A study using glc

Hamilton, R. J.; Raie, M. Y.

J. Chem. Educ. 49,507 (1972)

Olive, linseed, and cottonseed oils oxidized with KMnO_4 - NaIO_4 mixture under conditions which result in the liberation of free fatty acids.

These can be injected directly onto a glc column. Standard acid mixture required for calibration.

***ORG KIN NOPROC PREP PROJ SEQ 3**

Conversions From Cyclohexanol: An undergraduate laboratory project.
Hanna, S. B.; Wroblewski, J. T.; Bohanon, J. T.; Peace, B. W.
J. Chem. Educ. 48, 556 (1971)
Flow chart for a series of preparations - cyclohexene, adipic acid, cyclohexanediols, caprolactam, cyclopentanone, cyclopentanol, cyclopentene, cyclopentanediols.

***ORG GRIGNARD NMR PREP 4 HAZARD**

Some Deuterium Labelling Experiments
Hanson, J. R.
J. Chem. Educ. 59, 342 (1982)
Procedures for deuteration of active H compounds with NaOH (HAZARD: sodium with D₂O, cautions not stated). Also preparation from Grignard, and analysis by NMR.

***ORG ANAL CHROMATOG IR MASSPEC NMR PROOF TLC 3**

Characterization of Juglone
Hanson, R. W.
J. Chem. Educ. 53, 400 (1976)
Students are given problem of proving that the product prepared by the method of Jesaitis and Krantz is in fact juglone. Method for doing this plus some spectral data given.

***ORG ANAL GC INSTR IR ISOMERS 4**

Isomerization of Xylenes: An experiment for the organic or instrumental laboratory
Harbison, K. G.
J. Chem. Educ. 47, 837 (1970)
Pure o-, m-, and p-xylene isomerized by AlCl₃-HCl. Analyzed by ir or gc to find mechanism.

***ORG CATAL DEMO PHOTO PREP SUBSTRXN 3**

Photochemical Catalysis of an Aliphatic Substitution Reaction
Hart, H.
J. Chem. Educ. 38, A28 (1961)
Bromination of hexane. A Chem-Ed Tested Demo.

***ORG BIOCHEM FREERAD MISTAKE PREP REDOX 3**

Oxidative Coupling of Phenols: A biomimetic undergraduate organic laboratory experiment
Hart, H.; Reilly, J. L.
J. Chem. Educ. 55, 120 (1978)
Lead dioxide oxidation of 2,6-di-tert-butylphenol and radical coupling followed by tautomerization to a hydroquinone. Oxidation gives a quinone. Note: one structure is incorrect. Caution: hydroquinones are potential skin irritants.

***ORG GEOM ISOMERS PREP REARRANGE 3**

The Rearrangement of Diazotized 4-Bromobenzophenone Hydrazone: A Stereospecific Reaction
Hawbecker, B. L.
J. Chem. Educ. 47, 218 (1970)
4-Bromobenzophenone plus hydrazine gives separable syn- and anti-isomers. Separately rearranged to anilides, identified by comparison with products from benzoyl halides and aniline.

***ORG FRIEDEL.CRAFTS GC REARRANGE 3**

Dealkylation-Isomerization of p-di-t-Butylbenzene
Hawbecker, B. L.; Kurtz, D. W.; Elliott, H. A.
J. Chem. Educ. 55, 777 (1978)
Aluminum chloride catalyzed dealkylation equilibria.

***ORG NAME PREP 3**

The Aldol Condensation: A simple teaching model for organic laboratory
Hawbecker, B. L.; Kurtz, D. W.; Putnam, T. D.; Ahlers, P. A.; Gerrit, G. D.
J. Chem. Educ. 55, 540 (1978)
Benzaldehyde-acetone base catalyzed reaction gives (1) benzalacetone and (2) dibenzalacetone; only (1) converted to 2,4-dinitrophenylhydrazone. But (our comments) should purify benzaldehyde before start? And uv could be introduced.

***ORG HETEROCYCLIC PREP SEQ 3**

Preparation of Phenanthridone - A Multipurpose Experiment for the Organic Laboratory
Hawbecker, B. L.; Radovich, D. A.; Tillotson, L. G.
J. Chem. Educ. 53, 398 (1976)
Reaction sequence: Conversion of 9-fluorenone to its hydrazone, diazotization, and rearrangement to phenanthridone. One period.

***ORG HPLC ORGANOMETAL 4**

Acetylation of Ferrocene. Monitoring a Chemical Reaction by HPLC
Haworth, D. T.; Liu, T.

J. Chem. Educ. 53,730 (1976)

Acetylation of ferrocene by acetic anhydride in the presence of phosphoric acid. Ice-quenched samples from reaction batch. Silica column, UV detection, 500 psi.

***ORG GC IR MASSPEC NMR QUAL 3 4**

A Nontraditional Qualitative Organic Analysis Experiment

Haynes, L. W.

J. Chem. Educ. 60,234 (1983)

Components of ligroin are separated by preparative GC and analyzed spectroscopically to identify major and other components.

***ORG HETEROCYCLIC PHARM PREP 3 HAZARD**

Synthesis of the Anticonvulsant Drug 5,5-Diphenylhydantoin: An Undergraduate Organic Chemistry Experiment

Hayward, R. C.

J. Chem. Educ. 60,512 (1983)

One step synthesis from benzil and urea is followed by pptn. with CO₂ and recrystallization. No ref. to IR or NMR confirmation of structure. Appears in Adams, Johnson, & Wilcox, 3rd and earlier, so nothing new here except CO₂ as titrant. Use of dil. HCl in earlier versions. (HAZARD: Hydantoins are physiologically active.)

***ORG HETEROCYCLIC NATPROD PHARM PREP SEQ 3 4 HAZARD**

The Prototype Compound for the Oral Anticoagulants

3,3'-Methylene bis(4-hydroxycoumarin)

Hayward, R. C.

J. Chem. Educ. 61,87 (1984)

Following a brief description of oral anticoagulants, a procedure for preparing the title compound in two steps is provided. o-Hydroxyacetophenone and diethyl carbonate are condensed with sodium hydride (flammability HAZARD) to 4-hydroxycoumarin which is then condensed with aqueous formaldehyde (HAZARD: carcinogen) to dicumarol (HAZARD: powerful physiologic activity).

***ORG COLUMNC CYCLOADDITION NMR PREP 4 HAZARD**

Undergraduate Experiments With Tetrachlorobenzene

Heany, H.; Marples, B. A.

J. Chem. Educ. 45,801 (1968)

N-Butyllithium, amyl nitrite, hexachlorobenzene. Tetrachlorobenzene from hexachlorobenzene plus lithium or tetrachloroaminobenzoic acid diazotized, gives 2 plus 2 cycloaddition to mesitylene or anisole. HAZARDS: tetrachlorobenzene derivatives may be carcinogens. Butyllithium is flammable; amyl nitrite is toxic.

***ORG CARBENE PREP PROJ 4**

Transannular Carbene Reactions: An intermediate organic laboratory experiment

Hecht, S. S.

J. Chem. Educ. 48,340 (1971)

Reports 5-wk advanced project on study of aprotic decomposition of lithium salts of tosylhydrazones. May involve catalytic hydrogenation (room temp.) and cyclopropane synthesis from CH₂I₂.

***ORG PHYS KIN TITN 3**

The Hydrolysis of t-Butyl Chloride: A lecture and a laboratory experiment
Herbrandson, H. F.

J. Chem. Educ. 48,706 (1971)

Method of intermittent titration. Data can be collected in about 5 min. per run.

***ORG DEMO PTC 3 HAZARD**

Purple Benzene: Solubilization of Anions in Organic Solvents

Herriott, A. W.

J. Chem. Educ. 54,229 (1977)

Permanganate ion extracts into benzene when ALIQUAT-336 is added to the system. ALIQUAT-336: comm. prep. tricaprylmethylammonium chloride soln. A tested demonstration.

HAZARD: Benzene is a carcinogen.

***ORG MISTAKE ORGANOMETAL PREP TLC 3**

Optimizing Experimental Conditions: The use of TLC to follow the course of a reaction

Herz, J. E.

J. Chem. Educ. 43,599 (1966)

Acetylation of ferrocene conditions varied; unreacted, mono and disubstitution products analyzed by tlc. Note: there is only one disubstitution product; rings are free to rotate.

***ORG NAME PTC QUAL 3**

A Permanganate Test for Unsaturated Fats Using Phase Transfer Catalysis
Hill, J. W.; Boyd, T. C.

J. Chem. Educ. 56 ,824 (1979)

A Chem Ed compact. Adogen-464 or Aliquat-336 (methyltrialkylammonium chlorides) improves efficacy of Baeyer test. Quantitative also.

***ORG NAME PREP PTC 3**

An Ether Synthesis Using Phase Transfer Catalysis

Hill, J. W.; Corredor, J.

J. Chem. Educ. 57 ,822 (1980)

Williamson synthesis of benzyl butyl ether, using 50 percent NaOH (Caution) and tetrabutylammonium salt.

***ORG PREP PTC REDOX 3**

Oxidation of Alcohols Using Calcium Hypochlorite and Solid/Liquid Phase Transfer Catalysis

Hill, J. W.; Jenson, J. A.; Henke, C. F.; Yartz, J. G.; Pedersen, R. L.

J. Chem. Educ. 61 ,1118(1984)

An improved method to oxidize benzyl alcohol to benzaldehyde and several secondary alcohols to ketones uses solid calcium hypochlorite in a phase transfer reaction with tetrabutylammonium hydrogen sulfate as catalyst. The procedure for oxidizing 1-phenylethanol is detailed; good student yields are obtained.

***ORG PREP PTC 2**

A Catalyst for the Synthesis of Soap

Hill, J. W.; Solberg, S. J.; Hill, C. S.

J. Chem. Educ. 59 ,788 (1982)

Use of a phase transfer catalyst speeds the alkaline hydrolysis of fat. Not very sophisticated isolation.

***ORG PREP 3**

Phenyl Acetate Preparation from Phenol and Acetic Acid

Hocking, M. B.

J. Chem. Educ. 57 ,527 (1980)

The equilibrium amount of ester formed is shown to be 13%. By slow removal of H₂O-HOAc via a 1-meter fractionating column, yield of ester raised to 55%. Not written as a student experiment but could be used.

***ORG GC GRIGNARD NATPROD PHEROMONES REDOX 3 4**

A Reinvestigation of the Synthesis of 4-Methyl-3-heptanol

Hoffman, R. V.; Alexander, M. D.; Buntain, G.; Hardenstein, R.; Mattox, McLaughlin, S.

J. Chem. Educ. 60 ,78 (1983)

Correction of an earlier report (Einterz, et al., J. Chem. Ed. 54,382 (1977)) describing the synthesis by Grignard rxn. of the diastereomers of 4-methyl-3-heptanol (the aggregation pheromone of the European elm bark beetle). The actual products are 4,5-dimethyloctane and 4-methyl-3-heptanone, GC and IR identification parameters given.

***ORG TECHNIQUE 3 HAZARD**

Small Scale Organic Techniques: Filtration and crystallization

Horak, V.; Crist, D. R.

J. Chem. Educ. 52 ,664 (1975)

Use of filter stick illustrated by purification of benzanilide. Filter hot solution through cotton, crystallize, withdraw mother liquor, transfer crystals to storage. Explicit with drawings. HAZARD: CCl₄, substitute.

***ORG BACTERIA BIOCHEM NATPROD PREP 1 2**

Winemaking in The Chemistry Laboratory

Horn, D. E.

J. Chem. Educ. 54 ,375 (1977)

Directions for production of a red table wine as part of a course in chemistry of winemaking. About 4 months minimum.

***ORG CATAL FRIEDEL.CRAFTS PREP 3**

The Synthesis of 4,4'-Di-tert-Butyl Biphenyl: A Sophomore Organic Chemistry Experiment

Horne, D. A.

J. Chem. Educ. 60 , 246(1983)

Title compd is prepared from biphenyl and t-butyl chloride in CH₂Cl₂ w. anhyd. FeCl₃ catalyst. May be combined w. prepn of t-butyl chloride(also described). One 4-hr lab period.

***ORG EXCHANGE IR PREP 4**

The Preparation and Properties of n-Amyl Alcohol-OD: An Exchange Experiment

Hoster, D. P.; Abbott, S.

J. Chem. Educ. 48 ,135 (1971)

Pentyl alcohol and boric acid gives ester, hydrolyzed by D₂O. Expensive for any but a single project.

*ORG ANAL PREP QUAL 3

A Convenient Method for the Preparation of 2,4-Dinitrophenylhydrazones
Howell, B. A.

J. Chem. Educ. 61,176 (1984)

Derivatives are prepared by dissolving the carbonyl compound and 2,4-dinitrophenylhydrazine in dimethylformamide and then adding acid; the procedure for flavenone is described. Advantages include increased yield and decreased acidity.

*ORG GC PHEROMONES PREP REARRANGE REVIEW SUBST.RXN 3 HAZARD

Preparation of 2-Bromopentane

Howell, B. A.; Kohrman, R. E.

J. Chem. Educ. 61,932 (1984)

A review of the problems involved in converting secondary alcohols to halides (30 references) is followed by an analysis to find the best route for conversion of 2-pentanol to 2-bromopentane for an introductory level organic lab. The chosen method, using phosphorous tribromide, gives nearly pure 2-bromopentane if the technique is good.

*ORG PREP REDOX 3

Sodium Perborate Oxidation of an Aromatic Amine

Huestis, L.

J. Chem. Educ. 54,327 (1977)

4-Chloroaniline to 4,4-dichloroazobenzene and azoxybenzene. Caution: sodium perborate is a solid oxidant.

*ORG PHARM PREP 3 HAZARD

Preparation of Sulfanilamide From Aniline

Hurd, E. C.; Yang, J. W.

J. Chem. Educ. 46,697 (1969)

Modification of usual procedure to save time, eliminating one step.

HAZARDS: chlorosulfonic acid, trifluoroacetic acid.

*ORG PHYS FREERAD GC KIN 3 HAZARD

Relative Reactivities in Free Radical Systems

Hutchinson, M. J.; Mosher, M. W.

J. Chem. Educ. 48,629 (1971)

GC analysis of start, during and conclusion used to estimate ratios of rates of reaction of each of several free radicals with different hydrocarbons and derivatives. Radical initiators: peroxides, nitrosyl chloride, chlorine are all HAZARDS (strong oxidants, toxic).

*ORG PREP REDOX 3

Selective Reduction of Dinitrobenzenes: An organic laboratory experiment

Idoux, J. P.; Plain, W.

J. Chem. Educ. 49,133 (1972)

Ammonium sulfide reagent and NaHS reagent are compared in reaction with 1-substituted-2,4-dinitrobenzenes. See also DeKoning, this file (1976).

Warning: skin irritants.

*ORG ASSOC ELECTROCHEM PREP PROJ REDOX SEQ 3 4 HAZARD

Preparation of t-Nitrosobutane Dimer: A combined experiment in organic synthesis and electrochemistry

Iversen, P. E.

J. Chem. Educ. 51,489 (1974)

Tungstate-peroxide oxidation of t-butylamine; product electrolytically reduced (for equipment, refer earlier, J. Chem. Educ.) to the hydroxylamine. Polarographic analysis, then bromine oxidation to nitroso compound, t-BuNO, and dimerization to (t-BuNO)₂. Explicit directions. HAZARD: bromine.

*ORG APPARATUS ELECTROCHEM PREP 3

Reduction of Trichloroacetic Acid to Dichloroacetic Acid: An organic electrosynthesis experiment

Iversen, P. E.

J. Chem. Educ. 48,136 (1971)

Dropping mercury electrode in three-electrode divided cell followed by continuous liquid-liquid extraction. Potentiostat.

*ORG CHIRAL NMR PREP RESOLUTION 4

An NMR Determination of Optical Purity

Jacobus, J.; Raban, M.

J. Chem. Educ. 46,351 (1969)

In three labs! Resolution of alpha-phenylethylamine (tartrate crystallization) and of O-methylmandelic acid (ephedrine cryst.), conversion of latter to acid chloride, and nmr determinations of optical purity. Uses nmr of all three diastereomers.

*ORG GEOM PHOTO TLC 3 HAZARD

The Photoisomerization of Azobenzene: A TLC experiment for the undergraduate organic laboratory

Janssen, J. F.

J. Chem. Educ. 46,117 (1969)

UV light source or sun. HAZARD: benzene.

***ORG HETEROCYCLIC PHOTO TLC 4**

Photolysis of a Heterocyclic Compound: An advanced undergraduate experiment
Jarrar, A. A.

J. Chem. Educ. 51,755 (1974)

Benzofurazan oxide prepared; reaction with dibenzylmethane gives a quinoxaline-1,4-dioxide. Mercury lamp photolysis gives a benzimidazolone, reactions followed by TLC.

***ORG DIELS-ALDER GEOM GRIGNARD PREP PROOF SEQ 4 HAZARD**

Spectroscopy And Structure Elucidation: Coordinated Experimental Exercises in Advanced Organic Chemistry

Jefford, C. W.; McCreadie, R.; Muller, P.; Pfyffer, J.

J. Chem. Educ. 50,181 (1973)

Isophorone and methyl Grignard in two different reactions. One with copper acetate gives sat'd cyclic ketone which is then brominated. The other, by subseq. dehydr. gives dienes, one of which reacts (Diels-Alder). HAZARD: benzene - carcinogen. Use another solvent.

***ORG PREP SUBST.RXN 4**

Bridgehead Reactivity: An experiment in organic chemistry

Jefford, C. W.; McCreadie, R.; Muller, P.; Siegfried, B.

J. Chem. Educ. 48,708 (1971)

Subl. at red. pressure. Qualitative comparison of rates of nucleophilic substitution of adamantane (by bromination of adamantane), t-butyl bromide, and 9-bromotryptycene (from diazotized anthranilic acid to benzyne plus 9-bromoanthracene). HAZARD: isoamyl nitrite.

***ORG ENVIRON NATPROD PREP 3 HAZARD**

Juglone: An organic chemistry-ecology interaction experiment

Jesaitis, R. G.; Krantz, A.

J. Chem. Educ. 49,436 (1972)

Synthesis from 1,5-dihydroxynaphthalene by chromic acid oxidation. Acetyl juglone may be prepared from the product. Effect on sprouting of seeds studied. HAZARD: chromic acid is on the carcinogens list.

***ORG IR PREP REDOX 3**

The Selective Reduction of Meta- (And Para-) Nitroacetophenone
Jones, A. G.

J. Chem. Educ. 52,668 (1975)

Reduction by metal-acid gives amino ketone; by borohydride gives nitroalcohol.

***ORG ANAL PHYS NMR PREP SEQ 5 HAZARD**

The Synthesis and Proton NMR Spectrum of Methyl 7-Cycloheptatrienylacetate: An advanced undergraduate laboratory experiment

Jurch, G. R.; Johnston, M. D.; Perry, J. W.; Dettuy, T. E.

J. Chem. Educ. 57,743 (1980)

Designed as a final problem for BS degree, and also suitable for graduate students. Sequence begins with tropicium fluoroborate, and ends with its conversion to the title compound. This is studied by NMR, including studies with the shift reagents $\text{Pr}(\text{fod})_3$ and $\text{Eu}(\text{fod})_3$. Caution: there are assorted "hazards" in this exp't which the advanced student should be well able to deal with, but the instructor should be aware of. Detailed, well-written.

***ORG FREERAD PREP 4**

Organoboranes as Alkylating Agents.

Kabalka, G. W.; Baker, J. D., Jr.; Neal, G. W.

J. Chem. Educ. 53,549 (1976)

Prep'n of trihexylborane using 1-hexene and borane dimethylsulfide. Reactions of this compound with methyl vinyl ketone under free radical conditions, and also with benzoquinone. 1 lab period. Some discussion.

***ORG NAME PREP 3 4**

The Hydroboration-Oxidation of Alkenes: A Convenient Anti-Markownikoff Hydration Experiment

Kabalka, G. W.; Hedgecock, H. C., Jr.

J. Chem. Educ. 52,745 (1975)

1-Octene, 1-hexene, etc. hydroborated w. $\text{BH}_3:\text{S}(\text{CH}_3)_2$ complex. Trimethylamine-N-oxide used as an oxidant. HAZARD: possible carcinogen. Suggest use H_2O_2 and base, although this is trickier. Needs inert atmosphere.

***ORG CHIRAL HISTORIC IONX POLARIM PROJ RESOLUTION 3**

The Resolution of Racemic Acid: A classic stereochemical experiment for the undergraduate laboratory

Kauffman, G. B.; Myers, R. D.

J. Chem. Educ. 52,777 (1975)

Low power microscope. Preparation, crystallization and separation of sodium ammonium (+) and (-) tartrates. Additional projects.

***ORG PREP REDOX 3 HAZARD**

Student Preparation of Acetone from 2-Propanol

Kauffman, J. M.; McKee, J. R.

J. Chem. Educ. 59,862 (1982)

Hypochlorite oxidation, simple procedure. HAZARD: use of a flame to distill acetone is not for me. Why not use a steam bath?

***ORG CATAL COLUMNC PREP PROJ 4 5 HAZARD**

Student Laboratory Preparation of Cis- and Trans-4-t-Butylcyclohexanols
Kaye, I. A.

J. Chem. Educ. 43,535 (1966)

Raney nickel hydrogenation of 4-t-butylcyclohexanone gives mix; hydrogen phthalate is separated. Altered reduction conditions gives more cis, separated by chromatog. Difficult. HAZARD: Raney nickel (pyrophoric), benzene, carcinogenic, use a substitute.

***ORG CATAL HPRESS 3 HAZARD**

Catalytic Hydrogenation of Ketones at Moderate Pressures: An organic demonstration-experiment

Kaye, I. A.

J. Chem. Educ. 49,131 (1972)

Reduction of ketones by secondary alcohols using Raney-nickel catalyst, at 50 psi. Identification parameters given. HAZARD: Pyrophoric catalyst.

***ORG ADDITION FREERAD NATPROD PHOTO PREP 4 5 HAZARD**

Free-Radical Addition of Tetrahalomethanes to Beta-Pinene: Experiments in organic chemistry

Kaye, I. A.; Odum, R. A.

J. Chem. Educ. 53,60 (1976)

Three preparations. HAZARD: benzoyl peroxide, carbon tetrachloride, (carcinogen).

***ORG ANAL PREP TECHNIQUE 3**

Recrystallization and Melting Point Determination: An introductory organic exercise

Kaye, I. A.; Yuska, H.

J. Chem. Educ. 47,703 (1970)

Ketone identification by prep'n of semicarbazones and 2,4-dinitrophenylhydrazones. Unknown.

***ORG DIELSALDER PREP 3 HAZARD**

A Diels-Alder Student Preparation

Kellett, J. C., Jr.

J. Chem. Educ. 40,543 (1963)

Tetracyanoethylene and anthracene. HAZARD: benzene; use another solvent.

***ORG PHYS DEMO HISTORIC 3**

A Dramatic and Relevant Demonstration of Ring Strain

Kelly, T. R.

J. Chem. Educ. 54,228 (1977)

Addition of cyclobutane-alpha-pinene to crystalline iodine results in an exceptionally exothermic (addition-rearrangement) reaction attended by the evolution of a purple cloud of unreacted iodine. A tested demonstration.

***ORG DEMO REDOX 1 2**

Silver Mirror

Kemp, M.; Slotnick, H.

J. Chem. Educ. 58,655 (1981)

Silver mirrors produced by reduction of Ag(I) with various sugars.

Procedure designed to reduce explosion hazard from ammoniacal silver sol'ns.

A tested demo.

***ORG PHYS NMR PROJ 5**

The Disproportionation of an Unsymmetrical Azine: An nmr experiment for the undergraduate organic laboratory

Kenny, D. H.

J. Chem. Educ. 57,462 (1980)

Reports successful senior class project based on the preparation and disproportionation of the mixed azine of benzaldehyde and acetophenone. The reaction is followed by NMR analysis.

***ORG PHYS KEQ NMR NOPROC THERMO 3**

Relative Carbonium Ion Stabilization Energies: An NMR Experiment for the Undergraduate Organic Laboratory

Kenny, D. H.; Sandel, V. R.; Osterby, B. R.

J. Chem. Educ. 51,253 (1974)

Stable trityl salts are used to determine equilibrium constants for one salt dissociation by nmr.

***ORG NAME PREP SEQ 3 HAZARD**

The Preparation of 3-Phenylanthranil: A sequential experiment for the undergraduate organic laboratory

Kenny, D. H.; Strieter, J. C.

J. Chem. Educ. 49,130 (1972)

o-Benzoyl benzoic acid to o-benzoylbenzamide. 2-Aminobenzophenone (by Hofmann) reacts sod. azide; thermal rearrange gives product. HAZARD: sodium azide (storage hazard, toxic), chloroform (carcinogen).

***ORG NAME PREP 3**

The Amine-Catalyzed Perkin Condensation: A class project
Ketcham, R.
J. Chem. Educ. 41,565 (1964)
Reaction carried out using a variety of subst. benzaldehydes and phenylacetic acids.

***ORG ANAL QUAL 3**

A Simple Test for the Detection of Phosphorus in Organic Compounds
Ketcham, R.; Low-Beer, A.
J. Chem. Educ. 38,414 (1961)
Short note reports that filter paper moistened with AgNO₃, placed over the mouth of the test tube immediately after a sodium fusion turns black if phosphorus is present.

***ORG ANAL CHROMATOG NOPROC PREP 3**

The Unique Properties of 2,4-Dinitrobenzenesulfonyl Chloride
Kharasch, N.
J. Chem. Educ. 33,585 (1956)
Many reactions of this reagent given. Purify chromatographically; experimental details by reference.

***ORG APPARATUS DEMO OPTICAL ORD 2 3**

A Device for Easy Demonstration of Optical Activity and Optical Rotation Dispersion.
Kinney, J. B.; Skinner, J. F.
J. Chem. Educ. 54,494 (1977)
A portable device is constructed from plexiglass tubing and sheet for the simultaneous demonstration of optical activity and optical rotatory dispersion. Can be used by individuals or with an overhead projector. Qualitative only. A tested demonstration.

***ORG PREP PROJ REARRANGE SEQ 4 5 HAZARD**

Intermolecular Reactions: An organic practical project
Knipe, A. C.
J. Chem. Educ. 51,209 (1974)
4-Nitrobenzenesulfonyl chloride + 2-aminoethanol gives compound which gives base-catalyzed nucleophilic aromatic substitution-rearrangement. Characterizations by ir, nmr, uvis. HAZARD: benzene - use substitute.

***ORG CLATH PREP 3 4**

Separation of Organic Compounds with Urea and Thiourea
Kobe, K. A.; Reinhart, L. R.
J. Chem. Educ. 36,300 (1959)
Urea and thiourea form adducts (inclusion compounds) with many organic molecules. 14 typical compounds are listed plus instructions for forming the clathrates. Avoidable hazard: CCl₄ solutions. A very simple, high-yield preparation.

***ORG PHOTO PREP REARRANGE 3 HAZARD**

The Rearrangement of 1,1-Dimethyl-1-Phenacylhydrazinium Bromide
Koga, M.; Stamegna, A. P.; Burke, D. J.; Anselme, J. P.
J. Chem. Educ. 54,111 (1977)
Prep. from phenacyl bromide (CAUTION: lachrymator) and dimethylhydrazine. HAZARD: toxic, absorbed into skin. Thermal and photolytic rearrangement.

***ORG ASSOC FREERAD GC PREP 3**

Two Organic Laboratory Experiments With Benzylic Hydrocarbons.
Kolb, K. E.; Helmer, B. J.
J. Chem. Educ. 56,201 (1979)
Preparative dimerization; cumene gives 2,3-diphenyl-2,3-dimethylbutane. Relative reactivity by reaction in gc, and peak height anal.

***ORG PREP REDOX 2 HAZARD**

Preparation of Succinic Acid From Maleic Anhydride: A simple organic laboratory reduction
Kolb, K. E.; Pacey, G. E.
J. Chem. Educ. 51,345 (1974)
Zn/HCl reduction. HAZARD: maleic anhydride is toxic, irritant.

***ORG IR NMR PREP TLC 3**

Preparation of the Members of an Homologous Series: An organic chemistry experiment
Kolenbrander, H. M.
J. Chem. Educ. 47,56 (1970)
Synthesis of S-alkyl derivatives of homocysteine, starting with DL-homocysteine thioacetone hydrochloride and a primary iodoalkane. Explicit directions. Not very stimulating.

***ORG APPARATUS CATAL HPRESS ORGANOMETAL PREP 5 HAZARD**

Reaction Rates at High Pressures: The Oxo Reaction

Krabacher, B.; Kirch, L.; Orchin, M.

J. Chem. Educ. 37,31 (1960)

In an autoclave with hydrogen under 1300 psi, react olefins with CO, using a dicobaltoctacarbonyl catalyst. HAZARDS: the whole experiment is hazardous - toxic compounds and hydrogen at high temperature and pressure.

***ORG APPARATUS FRIEDEL-CRAFTS PREP 3**

Apparatus for the Friedel-Crafts Reaction

Kremer, C. B.; Wilen, S. H.

J. Chem. Educ. 38,306 (1961)

Simple reaction chamber construction from readily-available glassware.

Explicit directions for prep'n of tert-butylbenzene; successful preparation of other compounds reported.

***ORG PREP REDOX 3 HAZARD**

Aqueous Chromic Acid Oxidation of Secondary Alcohols in Diethyl Ether

Krishnamurthy, S.; Nylund, T. W.; Ravindranathan, M.; Thompson, K. L.

J. Chem. Educ. 56,203 (1979)

Oxidation of 2-methylcyclohexanol in ether. Results given for other sec. alcohols. HAZARDS: chromium (VI) compounds are carcinogens; here there is likely some vapor. Reaction described is highly exothermic.

***ORG PREP 3 HAZARD**

Selective Reduction of Functionalized Carboxylic Acids with Borane-Methyl

Sulfide: A convenient undergraduate organic experiment

Krishnamurthy, S.; Thompson, K. L.

J. Chem. Educ. 54,778 (1977)

Reduction of nonanoic acid and 11-bromoundecanoic acid to alcohols.

HAZARDS: methyl sulfide toxic, unpleasant odor; borane, very reactive.

***ORG ANAL NMR PROJ 4**

Illustrating Spectral Simplification by PMR Shift Reagents: An Undergraduate Organic Experiment

Kuo, S. C.; Harriss, D. K.; Caple, R.

J. Chem. Educ. 51,280 (1974)

Europium and praseodymium shift reagents used to study nmr spectrum of 1,4-dihydroxynaphthalene-1,4-oxide in CDCl₃. Part of a projects lab.

***ORG PREP REDOX 3 HAZARD**

Use of a New Chemical Reducing Agent in the Undergraduate Organic Laboratory

Kushner, A. S.; Vaccariello, T.

J. Chem. Educ. 50,154 (1973)

Sodium bis(2-methoxyethoxy)aluminum hydride used to reduce benzophenone to the alcohol. Said to be much less of a fire hazard than lithium aluminum hydride. HAZARD: benzene solution; other solvents now used. Reader (DT) suggests consider NaBH₄ synthesis.

***ORG DEMO KIN 3**

Substituent Effects on the Benzene Ring: A demonstration

Lambert, F. L.

J. Chem. Educ. 35,342 (1958)

A series of lecture demonstrations for teaching aromatic chemistry - suitable for classes of approx. 50 students.

***ORG HETEROCYCLIC NATPROD PREP QUAL 3**

Heterocyclic Compounds from Milk

Lampard, M.

J. Chem. Educ. 53,256 (1976)

A simple experiment showing the relations between the hexoses and 5-membered heterocyclic compounds, using milk. Mucic acid is obtained by nitric acid oxidation and methods are given for the prep'n of furan, pyrrole, and thiophen, plus tests for their presence.

***ORG CONSUMERPROD PREP 3**

The Preparation of Vanillin from Eugenol and Sawdust

Lampman, G. M.; Andrews, J.; Bratz, W.; Hanssen, O.; Kelley, K.

Perry, D.; Ridgeway, A.

J. Chem. Educ. 54,776 (1977)

Separate preparations (title is misleading) of isoeugenol, then oxidation to vanillin, or direct oxidation of eugenol to vanillin (poor yield) or oxidation of sawdust lignin to vanillin; cellulose remaining made into paper. Nitrobenzene (CAUTION: absorbed skin) oxidant. Interesting, not easy, good chemistry.

*ORG NATPROD PREP PTC REDOX SEQ 3

A Phase Transfer Catalyzed Permanganate Oxidation:
Preparation of Vanillin from Isoeugenol Acetate

Lampman, G. M.; Sharpe, S. D.

J. Chem. Educ. 60, 503 (1983)

Straightforward, modern lab techniques. Eugenol $\Rightarrow$ isoeugenol acetate in acetic anhydride; product oxidized w. KMnO_4 using the PTC tricaprylmethylammonium chloride (Aliquat 336), CH_2Cl_2 medium. The vanillin acetate product is hydrolyzed & purified. IR, NMR, mp parameters given.

*ORG KIN 3

A Simple Kinetic Investigation of an Organic Reaction Mechanism

Landgrebe, J. A.

J. Chem. Educ. 41, 567 (1964)

Hydrolysis of t-butyl chloride in acetone, aq. NaOH. Conc. varied, time for depletion of OH ion (indicator) measured. See also Herbrandson.

*ORG PHYS KIN 3

Chromic Acid Oxidation of Alcohols: A simple experiment on reaction rates

Lanes, R. M.; Lee, D. G.

J. Chem. Educ. 45, 269 (1968)

Relative rates of reaction of pairs of alcohols followed visually. HAZARD: chromic acid is a carcinogen.

*ORG PREP REVIEW 3

Characterization of Organic Compounds with 2,4-Dinitrobenzenesulfonyl

Chloride: procedure and tables

Langford, R. B.; Lawson, D. D.

J. Chem. Educ. 34, 510 (1957)

A summary of procedures for the preparation of the derivatives of the sulfonyl chloride reagent named in the title. Explicit. Approx. 100 derivatives characterized. 40 references.

*ORG DEMO PREP 3

A Convenient Method for Demonstration of Stable Carbanions

Lansbury, P. T.

J. Chem. Educ. 38, 307 (1961)

Lithium aluminum hydride in pyridine solution is used 1) for the metallation of triphenylmethane and related weak organic acids whose conjugate bases are highly colored; 2) for the reductive cleavage of benzpinacolone and related ketones to highly colored carbanion solutions. No details. This article merely reports successful use of these reactions as lecture demonstrations.

*ORG ELECTROCHEM PREP REDOX 3

A Simplified Electrolytic Preparation of Iodoform: An anodic organic laboratory experiment

Lariviere, L. M.; Weber, J. E.

J. Chem. Educ. 45, 54 (1968)

Low voltage DC power source (circuit diagram). Rousch cell oxidation of acetone-potassium iodide. (Really an oxidation of iodide?). See also Helle, K.; Rijks, J.A.; Janssen, L.J.J.; Schuyt, J.W., J. CHEM. EDUC., 46, 518 (1969) for a simplified procedure.

*ORG CONSUMERPROD SEPARATION 3

Caffeine and Benzoic Acid in Soft Drinks

Laswick, J. A.; Laswick, P. H.

J. Chem. Educ. 49, 708 (1972)

A 1-hr exp't for beginning organic lab. Caffeine is extracted with CH_2Cl_2 , purified by sublimation. Benzoic acid, present as sodium benzoate, can be separately determined.

*ORG DEMO LUMIN PHOSPHOR PHOTO 3

Energy Transfer Demonstrations

Legg, K. D.

J. Chem. Educ. 50, 848 (1973)

Seven suggested solutions for demonstration of triplet-state processes (phosphorescence), and three for chemiluminescence. See also McHale, J.L.; Seybold, P.G., J. CHEM. EDUC., 53, 654 (1976).

*ORG ACBA CATAL KIN POLARIM 4

Experiments in Acid-Base Catalysis

Leisten, J. A.

J. Chem. Educ. 38, 132 (1961)

Gen. acid catalysis of mutarotation of glucose and specific acid catalysis of dimethyl ketal hydrolysis. Dilatometer. Guggenheim method.

*ORG PHYS KIN PROJ 4

A Group Experiment on the Hammett Sigma-Rho Relation

Leisten, J. A.

J. Chem. Educ. 38, 302 (1961)

A broadening of the familiar Phys. Chem. exp't on the second-order hydrolysis of an ester by aqueous alkali. Each student determines the rate constant for a different ester (a substituted methyl benzoate).

***ORG COURSE GC TECHNIQUE TLC 3**

A Practical Introduction to Separation and Purification Techniques for the Beginning Organic Chemistry Laboratory
Leonard, J. E.

J. Chem. Educ. 58,1022(1981)

Outline of five 3-hour labs that teach tlc, chemical separation by liquid-liquid extraction, distillation (monitored by gc) and recrystallization.

***ORG IR NAME NMR PREP PROJ SEQ UVIS 3**

An Undergraduate Organic laboratory Project Involving Independent Synthesis of Novel Flavones

Letcher, R. M.

J. Chem. Educ. 57,220 (1980)

A 4-lab period sequence leading to various flavones given. Substituent variation makes possible class project in which each student makes a unique final product. Reactions include two esterifications, two rearrangements, and ring closure to a flavone.

***ORG NAME NMR PHOTO PREP PROJ REDOX SEQ UVIS 4**

An Undergraduate Laboratory Project Involving Photocyclizations in Independent Syntheses of Novel Chrysenes and Phenanthrenes

Letcher, R. M.

J. Chem. Educ. 58,1020(1981)

A student project offering many variations. Requires at least four 4-hour lab periods and some specialized equipment including pressure hydrogenation and photolysis apparatus. Quite detailed directions.

***ORG ANAL IR MASSPEC NATPROD NMR PREP PROJ PROOF UVIS 4**

Structure Elucidation of a Natural Product

Letcher, R. M.

J. Chem. Educ. 60,79 (1983)

Students extract limonene from citrus peels and follow brief directions to prepare derivatives for identification (NMR,IR, mpt - some parameters given). The article is for instructors, not for students.

***ORG SEPARATION 3**

Oil Formation: An unexpected difficulty in an elementary organic laboratory experiment

Lewis, D. A.

J. Chem. Educ. 52,601 (1975)

Aniline derivatives are used in a separation procedure which gives oils at first, to challenge the student's recrystallization technique.

***ORG DEMO PREP SEPARATION SOLUB 3 HAZARD**

Recrystallization: Unexpected Behavior - An undergraduate organic demonstration or experiment

Lilje, K. C.; Macomber, R. S.

J. Chem. Educ. 50,567 (1973)

Pyridine hydrobromide (prepared) shows inverted solubility in CHCl₃ on heating. HAZARD: chloroform, possibly substitute?

***ORG TAUTOMERS 3**

Solvent Effect on The Keto-Enol Equilibrium of Acetoacetic Ester

Lockwood, K. L.

J. Chem. Educ. 42,481 (1965)

Bromine titration method. Group experiment.

***ORG ANAL STOICH 3**

Stoichiometry of the Reaction of Bromine with Phenols

Lockwood, K. L.

J. Chem. Educ. 42,482 (1965)

Various phenols and bromine in acetic acid. Remaining bromine displaces added iodide which is titrated with std. thiosulfate.

***ORG ORGANOMETAL PROJ REARRANGE 4 HAZARD**

Ferrocenylmethylation of Aniline

Non-Kinetic Determination of a Reaction Mechanism

Lombardo, A.; Bieber, T. I.

J. Chem. Educ. 60,1080(1983)

Products of rxn of the ferrocenylmethylation (from the trimethylammonium iodide) with aniline at 2 temperatures (100 deg and 186 deg) are identified by IR, GC, NMR analysis. (At the lower temperature the cation N-alkylates the aniline; at the higher, it alkylates the ring). Students are to propose rxn mechanism. Suitable for an integrated course.

***ORG PREP 3**

A More Convenient Method of Preparation of Amide Derivatives of Carboxylic Acids

Long, K. P.

J. Chem. Educ. 56,420 (1979)

Thionyl chloride with dimethylformamide cat. gives acid chlorides of unreactive acids; used to make amide derivatives for qual. ident.

***ORG CATAL PREP REDOX 3 HAZARD**

Palladium Catalyzed Reduction of Nitrobenzene

Mangravite, J. A.

J. Chem. Educ. 60,439 (1983)

Nitrobenzene $\rightarrow$ aniline using triethylammonium formate (and CH_2Cl_2) or cyclohexene (and ethanol) as the Pd-catalyzed reductants (and solvents). Hazards noted in article include nitrobenzene and aniline toxicity. One lab period. CAUTION: avoid CH_2Cl_2 as probable carcinogen; use ether.

***ORG IR NMR PREP 4**

An Unusual Reaction of a Ketal With Base: An undergraduate organic experiment

Marchand, A. P.

J. Chem. Educ. 49,841 (1972)

Starting compound is endo-1,2,3,4,5-pentachloro-7,7-dimethoxynorbornene. Reaction w. NaOH in DMSO gives compound to identify by nmr,ir. Study questions, suggested extensions. For instructors, not students, to read. WARNING: literature prep of the ketal involves carcinogens.

***ORG MASSPEC NMR PREP PROOF 3**

Structural Assignment of a $\text{C}(10)\text{H}(12)\text{O}(3)$ Ester by Mass Spectrometer
An Undergraduate Organic Problem

Marchand, A. P.; Jackson, D.

J. Chem. Educ. 53,390 (1976)

Differentiation of ethyl anisate (ethyl para-methoxybenzoate) from methyl para-ethoxybenzoate, student prep in both cases, by mass spectrometry. NMR is insufficient. Prep methods for both are outlined, mpts, bpts, refractive index and nmr and mass spectra given.

***ORG FREERAD GC QUANT 3 4 HAZARD**

Chlorination of 2,3-Dimethylbutane: A quantitative organic chemistry experiment

Markgraf, J. H.

J. Chem. Educ. 46,610 (1969)

Chlorination with sulfuryl chloride and N-chlorosuccinimide gives different ratios of products. Also solvent and temp. dependent. Anal. by g.c. HAZARD: benzoyl peroxide is a storage hazard.

***ORG ISOMERS PREP REDOX SEQ 3 HAZARD**

Stereochemical Correlations in the Camphor Series

Markgraf, J. H.

J. Chem. Educ. 44,36 (1967)

Isoborneol oxidized by chromic acid to camphor, then reduction with borohydride; competitive oxid. borneol-isoborneol to show steric effect. HAZARDS: chromic acid, carcinogen.

***ORG PHYS KIN NOPROC PREP PROJ 3 4**

Solvolysis of 1-Haloadamantanes: A physical organic chemistry experiment

Markgraf, J. H.; Anton, M. F.

J. Chem. Educ. 54,773 (1977)

1-Chloro, -bromo, -fluoro adamantanes prepared, solvolyzed in acetonitrile, ethanol, trifluoroethanol, as class project. Most by reference. See also Perkins, R., J. CHEM. EDUC., 56, 208, (1979).

***ORG ISOMERS NAME PREP PROJ SEQ 4**

Stereochemical Correlations in the Norbornane System: An advanced organic experiment

Markgraf, J. H.; Leung, P. T.

J. Chem. Educ. 47,707 (1970)

Explicit directions for a reaction sequence. (1) Reaction of 2-norbornanone with methylmagnesium iodide. (2) Prep'n of 2-methylene norbornane by Wittig reaction. (3) Oxymercuration-demercuration of product from (2).

***ORG PHOTO PREP REARRANGE 3**

Preparation and Rearrangement of 2,3-Diphenyl-2,3-butanediol

Markgraf, J. H.; Newton, T. A.

J. Chem. Educ. 56,344 (1979)

Photochemical reductive dimerization of acetophenone followed by acid catalyzed rearrangement and characterization of the single product.

***ORG ANAL CONSUMERPROD IR MASSPEC NMR TLC UVIS 3**

Analysis of Analgesic Mixtures: An Organic Chemistry Experiment

Martin, N. H.

J. Chem. Educ. 58,818 (1981)

Commercial analgesic mixtures analyzed by tlc using knowns for identification. Thick layer chromatography used followed by spectroscopic work. Note that phenacetin, a putative carcinogen, has now been removed from non-prescription drugs.

***ORG BIOCHEM CHEM.ENG ENZYME NATPROD PREP 2 3**

Ethanol from Corn: One Route to Gasohol

Maslowsky, E., Jr.

J. Chem. Educ. 60,752 (1983)

Short note: fermentation of frozen corn. alpha-Amylase and amyglucosidase are used in addition to yeast. Two lab. periods separated by one week (fractional distillation in the second period). Enzymes are commercially available. Complete expt. avail. from author.

***ORG PREP REARRANGE 3 HAZARD**

The Rearrangement of N-Benzyl-N,N-Dimethylhydrazinium Salts

Maytum, D.; Keene, B. R. T.

J. Chem. Educ. 49,215 (1972)

N,N-dimethylhydrazine reacts with benzyl bromide, then ylide formed and rearranged by powd. KOH at 110 deg. HAZARDS: (1) benzene, use substitute; (2) dimethylhydrazine is a carcinogen; the product may also be one.

***ORG GC GEOM ISOMERS NMR PREP 3**

Dehydration of 3-Hexanol: An nmr experiment for undergraduates

McConnell, J. F.

J. Chem. Educ. 48,552 (1971)

Preparative gc on AgNO₃/benzyl cyanide on Chromosorb W, separates cis- from trans-. Nmr used on these mixtures.

***ORG NATPROD PREP SEPARATION UVIS 3**

Furfural - Ubiquitous Natural Product

McCullough, T.

J. Chem. Educ. 49,836 (1972)

Prepn of furfural from orange rinds, etc., by refluxing with dilute HCl followed by steam distillation, identification by uv, and prepn of 2,4-dinitrophenylhydrazine.

***ORG NATPROD PREP 3**

C₃₀H₆₂O₂-A Solid Alcohol From Flower Petals

McCullough, T.

J. Chem. Educ. 51,228 (1974)

10,11-Triacontanediol from white prickly poppy, and acetylation.

***ORG CHIRAL NMR TECHNIQUE 4**

The Determination of Enantiomeric Purity Using a Chiral Lanthanide Shift Reagent

McGoran, E. C.; Cutter, B.; Morse, K.

J. Chem. Educ. 56,122 (1979)

Partially resolved alpha-phenylethylamine is used with chiral shift reagent, compared with calibration spectra of mixtures of known enantiomeric purity.

***ORG CATAL 3 4 HAZARD**

Kinetic Vs. Thermodynamic Control: An organic chemistry experiment

McGrew, L. A.; Kruger, T. L.

J. Chem. Educ. 48,400 (1971)

Tri-n-butylphosphine cat. dimer vs. trimer from m-chlorophenyl isocyanate.

HAZARD: m-chlorophenyl isocyanate, lachrymator, toxic; tri-n-butylphosphine, toxic, disagreeable odor.

***ORG PREP PTC REVIEW TECHNIQUE 4**

Phase-Transfer Catalysis Using Quarternary Onium Salts.

McIntosh, J. M.

J. Chem. Educ. 55,235 (1978)

Review of use of PTC in organic reactions. Methyltrialkylammonium chlorides used in example procedures: benzoin condensation, permanganate oxidation, nucleophilic substitution to form a nitrile from 1-chlorooctane. 55 references.

***ORG PREP 3**

Student Preparation of Alkanols from Alkenes

McKee, J. R.; Kauffman, J. M.

J. Chem. Educ. 59,695 (1982)

Short note gives explicit procedure for hydration of 1-hexene. Reaction demonstrates Markovnikov's rule. Structure "proof" by b.p.; better use ir or nmr.

***ORG FRIEDEL-CRAFTS HPLC ORGANOMETAL SAFETY 4**

Acylation of Ferrocene: Effect of temperature on reactivity as measured by reverse phase high performance liquid chromatography

McKone, H. T.

J. Chem. Educ. 57,380 (1980)

Ferrocene is substituted for the more toxic compound benzene for acetylation by a Friedel-Crafts reaction. Simple equipment and procedures. Analysis of the products by HPLC.

***ORG APPARATUS CATAL KIN PREP 4**

Liquid Phase Dehydrogenation of Isopropanol: Heterogeneous Catalysis Experiment

Mears, D. E.; Benson, J. E.

J. Chem. Educ. 43,325 (1966)

Ni(OAc)₂ and CrCl₃ reduced w. NaBH₄, or substitute Raney nickel. Volume hydrogen used to measure rate. Caution: pyrophoric catalyst.

***ORG HISTORIC ISOMERS MISTAKE 3**

The Determination of a Mechanism of Isomerization of Maleic Acid to Fumaric Acid

Meek, J. S.

J. Chem. Educ. 52,541 (1975)

Isomerization experiment to deduce mechanism is simple. This description gives history and invites deduction of mechanism from this. It is unique, nice. Errors: test tube #5 should be malic, not maleic acid. In discussion, test tube #4 should be #3. Reader(EM) warns to watch out for several confusing typos.

***ORG ANAL QUAL 3**

The Quinhydrone Test for Amines

Meek, W. F.; Entrikin, J. B.

J. Chem. Educ. 41,420 (1964)

Classification test for primary, sec. and tert. alkylamines. Also, with more reagent, for aryl.

***ORG IR LUMIN PHOTO PREP SEQ 4**

The Synthesis and Chemiluminescence of a Stable 1,2-Dioxetane: An Organic Chemistry Laboratory Experiment

Meijer, E. W.; Wynberg, H.

J. Chem. Educ. 59,1071(1982)

Adamantylideneadamantane-1,2-dioxetane synthesis (not easy), chemiluminescent reaction; identification parameters.

***ORG PREP SAFETY 3 HAZARD**

The Generation of Benzyne - A Warning

Mich, T. F.; Nienhouse, E. J.; Farina, T. E.; Tufariello, J. J.

J. Chem. Educ. 45,272 (1968)

An explosion is reported in an anthranilic acid diazotization used to prepare benzyne; a modification given here, using methylene chloride rather than THF as the solvent, is apparently safe.

***ORG POLYMER CONSUMERPROD DEMO PREP 4 HAZARD**

Laboratory Preparation of Cellophane

Miller, M.

J. Chem. Educ. 35,517 (1958)

Hood: CS₂, H₂S. Acid-proof goggles, rubber gloves, CS₂ in sealed flask at 30 deg. HAZARD: H₂S. Possibly for student use in polymer lab, but be careful.

***ORG PREP UVIS 3**

A Merocyanin Dye Preparation for the Introductory Organic Laboratory

Minch, M. J.; Shah, S. S.

J. Chem. Educ. 54,709 (1977)

Two step prep. gives a dye whose color changes with polarity of solvent. Visible spectra recorded in two or more solvents.

***ORG POLYMER NOPROC PREP PTC REDOX 3**

A Topical Alkene Preparation and Oxidation

Mitchell, R. H.; Hawkins, B. F.; West, P. R.

J. Chem. Educ. 56,526 (1979)

A Chem Ed Compact. Thermal depolymerization of polystyrene, oxidation of styrene by KMnO₄ (1) at room temp with methyltrialkylammonium chloride phase transfer catalyst, and (2) by alkaline reflux.

***ORG CONSUMERPROD 3 HAZARD**

The Extraction of Caffeine From Tea

Mitchell, R. H.; Scott, W. A.; West, P. R.

J. Chem. Educ. 51,69 (1974)

Use of teabags and sodium carbonate eliminates messy filtration in this expt. and gives a better product. Explicit directions. HAZARD (benzene) is avoidable.

***ORG TECHNIQUE 2 3 HAZARD**

Purification of the Pesticide "Methoxychlor": A beginning organic recrystallization experiment

Mitchell, R. H.; West, P. R.

J. Chem. Educ. 52,805 (1975)

A Chem-Ed compact. The impurity gives a bright blue color with bromine in acetic acid; hence, it is easy to test student's product. HAZARD: pesticides are extremely toxic.

***ORG DEMO LUMIN PREP 3 HAZARD**

A Facile and Effective Chemiluminescence Demonstration Experiment

Mohan, A. G.; Turro, N. J.

J. Chem. Educ. 51,528 (1974)

2,4,6-Trichlorophenol or 2,4-dinitrophenol esters of oxalic acid prepared, oxidized by 0.4M H₂O₂ in dimethyl phthalate, t-butyl alcohol. Chemiluminescence is spectacular. HAZARD: 98% H₂O₂, a rocket fuel, is an explosive hazard.

***ORG PHYS CHEM.ENG PROJ TECHNIQUE 4 HAZARD**

Production of Aromatic Hydrocarbons According to Extractive Distillation Process

Molinier, J.; Malmay, G.; Constrasti, J.
J. Chem. Educ. 60,148 (1983)

Design of a ternary azeotrope distillation system to recover aromatic from petroleum hydrocarbons using aniline. Requires a "pilot plant" type distillation column with automatic feed (no details given). The HAZARDS of benzene and aniline are inadequately described.

***ORG GEOM PREP 3**

The Stereospecific Synthesis of Trans-1,4-Disubstituted Cyclohexanes: An organic chemistry laboratory experiment

Monson, R. S.
J. Chem. Educ. 48,197 (1971)

1,4-Cyclohexanediols converted to 1,4-epoxycyclohexane in Dowtherm A over chromatography grade Al_2O_3 . Oxide treated with water and acid, or HCl , or HBr .

***ORG BIOCHEM PREP 3 HAZARD**

The Oxidation of Ethyl Lactate

Morgan, E. D.; Goddard, H.; Thomas, G. A.
J. Chem. Educ. 54,782 (1977)

Pyridinium chlorochromate oxidant (HAZARD: probably carcinogenic). Simple experiment with biochemical analogies.

***ORG ANAL QUAL 3**

Qualitative Test for Ketones, Aromatic Aldehydes, and Aliphatic Aldehydes
Morrison, J. D.

J. Chem. Educ. 42,554 (1965)

CrO_3 in $H_2SO_4-H_2O$ reagent (caution: CrO_3 is carcinogen - here used in minute amounts) in acetone distinguishes aliphatic, aromatic aldehydes; ketones are non-reactive.

***ORG PREP UVIS 3**

Preparation and Color of Azo-Dyes

Mosher, M. W.; Ansell, J. M.
J. Chem. Educ. 52,195 (1975)

Substituted anilines diazotized and coupled with beta-naphthol. Visible spectrum scanned to find wave length of maximum absorption; this is then correlated with the Hammett sigma constant.

***ORG PHYS CONSUMERPROD PREP SOLUB 1**

Antichap Lipstick and Nonbonded Interactions: A Nonscience Majors Laboratory Experiment.

Most, C., Jr.

J. Chem. Educ. 53,194 (1976)

Preparation of an antichap lipstick illustrates molecular interactions, solubility, thixotropy.

***ORG COLOR MAGIC PREP 2**

Nitration of Naphthol: A Laboratory Experiment

Mowery, D. F.

J. Chem. Educ. 59,689 (1982)

Nitration of naphthols with fuming nitric acid avoids a steam distillation.

Product of nitration of beta-naphthol is used to prepare pyrotechnic snakes (with picric acid), and product with alpha-naphthol is used to prepare Martius Yellow Dye. No separation of di- from mononitration products, but emphasis on student interest.

***ORG CONSUMERPROD PREP 3 HAZARD**

Experiencing Relevancy in Organic Chemistry- Hexachlorophene: Manufacturing The Great Clean-All

Moye, A. L.

J. Chem. Educ. 49,770 (1972)

2,4,5-Trichlorophenol, paraformaldehyde reaction - easy prep. HAZARD: hexachlorophene is toxic, dioxin is a possible side product.

***ORG CONSUMERPROD PHARM 2 HAZARD**

Extraction of Caffeine

Moye, A. L.

J. Chem. Educ. 49,194 (1972)

Caffeine from No-Doz instead of tea. Easy. Celite filter pad. HAZARD: chloroform, benzene - avoidable.

***ORG CHIRAL GC IR 3**

The Odor of Optical Isomers: An experiment in organic chemistry

Murov, S. L.; Pickering, M.

J. Chem. Educ. 50,74 (1973)

Separation of carvone (proced: Runquist, J. Chem. Educ.) from caraway seed oil, spearmint oil. Vac. dist'n.

***ORG ANAL TLC 3**

TLC on Microscope Slides: An organic chemistry experiment

Naff, M. B.; Naff, A. S.

J. Chem. Educ. 40, 534 (1963)

Early technique experiment gives method of preparing plates; three short experiments on separation of dyes, phenols.

***ORG CYCLOADDITION DIELS-ALDER PHOTO PREP 3 HAZARD**

A Novel Photochemistry Experiment Using a Diels-Alder Reaction

Nash, E. G.

J. Chem. Educ. 51, 619 (1974)

Hexachlorocyclopentadiene and cyclopentadiene compared in reaction with benzoquinone. Sunlight gives 2+2 photocycloaddition. HAZARD: toxic reactants.

***ORG FRIEDEL-CRAFTS NATPROD PREP 3 HAZARD**

Aromatic Nitro Musk Synthesis

Nash, E. G.; Nienhouse, E. J.; Silhavy, T. A.; Humbert, D. E.; Mish, M.

J. Chem. Educ. 47, 705 (1970)

m-Xylene is starting material: Friedel-Crafts and nitration reactions. Al/Hg amalgam. HAZARD: benzene, carcinogen - avoidable.

***ORG PREP PROJ 3**

Project Orientation in the Organic Laboratory

Neckers, D. C.

J. Chem. Educ. 47, 700 (1970)

Synthesis of dicyclopentyl ketone is followed by a variety of possible reactions, including kinetic studies, nmr, etc. from the literature or independently devised. An excellent example of the use of independent projects for a group.

***ORG GC NAME NMR PREP 3**

The Preparation and Dehydration of 1-Benzylcycloalkenols

Newkome, G. R.; Allen, J. W.; Anderson, G. M.

J. Chem. Educ. 50, 372 (1973)

Benzylmagnesium chloride reaction with several cycloalkenones followed by oxalic acid dehyd. Ratios of isomeric alkenes by gc and nmr.

***ORG GRIGNARD ORGANOMETAL PREP 3**

Preparation and Spectroscopic Examination of an Organometallic Compound

Newlands, M. J.

J. Chem. Educ. 55, 246 (1978)

Diphenylmethylsilane from methylchlorosilane; ir, nmr, mass spectrum suggested.

***ORG NOPROC PROJ 3**

The Synthesis of o-Acetylbenzoic Acid: An experiment for honors organic course

Newman, M. S.

J. Chem. Educ. 54, 191 (1977)

Describes a student project wherein student suggests method of prep, yield improvement, etc. Some suggested questions; extensions.

***ORG GC ISOMERS 3**

A Unique Laboratory-Lecture in Organic Chemistry

Nienhouse, E. J.

J. Chem. Educ. 46, 765 (1969)

Products from dehydration of 4-methyl-2-pentanol analyzed by gc (peak enhancement).

***ORG NAME PREP 3 HAZARD**

The Gabriel Synthesis of Benzylamine: An undergraduate organic experiment

Nigh, W. G.

J. Chem. Educ. 52, 670 (1975)

Easy prep; ir and nmr given. HAZARD: hydrazine is a carcinogen.

***ORG NAME NATPROD PREP 3**

Chemical Modification of Tung Oil

Nitidadhaprabhas, O.

J. Chem. Educ. 55, 544 (1978)

Fumaric acid adds to tung oil at 200-210 deg. Result is viscous, alkali soluble oil which dries to a varnish.

***ORG NAME PREP PROJ 3**

The Hantzsch Pyridine Synthesis: A factorial design experiment for the introductory organic laboratory

Norcross, B. E.; Clement, G.; Weinstein, K.

J. Chem. Educ. 46, 694 (1969)

Starting reagents: aldehydes, ethyl acetoacetate. Design conditions, incl. various oxidants.

***ORG NATPROD TLC 2 HAZARD**

Isolation of Oil of Clove and Separation of Eugenol and Acetyleneol

Ntamil, M. S.; Hassanali, A.
J. Chem. Educ. 53, 263 (1976)

Short notes describes a "first" experiment wherein a nice-smelling compound is extracted from cloves; characterized by TLC. HAZARD: CHCl_3 extraction: substitute something less toxic.

***ORG COLUMNC NATPROD PAPER PROJ SEPARATION SEQ 3 HAZARD**

Natural Product Chemistry: Laboratory research approaches for elementary organic courses

O'Connor, R.
J. Chem. Educ. 42, 492 (1965)

Extraction of caffeine from coffee beans, purif. by chromatog. and sublim. caffeine from theobromine. HAZARD: CHCl_3 , benzene - avoidable.

***ORG INORG POLYMER ASPIRIN DEMO PREP 1**

Chemistry for Parents and Children

O'Connor, R.
J. Chem. Educ. 37, 639 (1960)

Curricula and 6 experiments described for a laboratory-oriented "Saturday Science" course. Prep. of MgO , HCl , soap, bakelite, nylon, aspirin. Assorted demos.

***ORG ANAL PREP 4 HAZARD**

A Bench-Scale Preparation of Thioacetamide

O'Connor, W. F.; Cogswell, G. W.; Moriconi, E. J.
J. Chem. Educ. 35, 405 (1958)

From acetamide and P_2S_5 . An exercise for seniors in Organic Processes Lab. HAZARDS: both thioacetamide, and the benzene used as the solvent, are carcinogens.

***ORG PREP 4 HAZARD**

Aqueous Bromination With Bromine Chloride: A simplified method for the preparation of 2,6-dibromo-4-nitrophenol

Obenland, C. O.
J. Chem. Educ. 41, 566 (1964)

p-Nitrophenol reacts with sodium bromide-chlorine. Prep. requires skill. HAZARD: halogens, interhalogens (burns).

***ORG PREP 3**

Direct Esterification of Phenols: Textbook errors 48

Offenhauer, R. D.
J. Chem. Educ. 41, 39 (1964)

Preparation of p-cresyl hexanoate by direct reaction, remove water.

***ORG COLOR PHOTO 3**

A Demonstration of Color Development: Formation of the Subtractive Primary Dyes

Olson, E. S.
J. Chem. Educ. 55, 513 (1978)

Chemistry of color photography applied to an organic lecture demo. Overhead projector, stacked petri dishes with developed dye.

***ORG PREP 6 HAZARD**

Purification of Nitromethane by Crystallization

Parrett, F. W.; Sun, M. S.
J. Chem. Educ. 54, 448 (1977)

Crystallization from ether at -60 - 78 deg Celsius.

HAZARD: Toxic, explosive. This is a research note, not a student experiment.

***ORG CYCLOADDITION FRIEDEL-CRAFTS ISOMERS PHOTO SEQ 4 HAZARD**

Stereospecific Thermal Cycloadditions and Catalyzed Isomerizations: An organic laboratory project

Pasto, D. J.; Duncan, J. A.; Silversmith, E. F.
J. Chem. Educ. 51, 277 (1974)

Five periods lab report outline given. Friedel-Crafts rx. of benzene with fumaryl chloride yields cis- and trans-1,4-diphenyl-2-butene-1,4-diones.

Photochemical rx. of trans- to cis-, and cycloaddition reaction products. HAZARD: benzene and chloroform are carcinogens.

***ORG COLUMNC NAME PREP SEQ TLC 3 HAZARD**

The Ethylene Ketal Protecting Group in Organic Synthesis: An undergraduate laboratory experiment

Paulson, D. R.; Hartwig, A. L.; Moran, G. F.
J. Chem. Educ. 50, 216 (1973)

Ethyl acetoacetate to 4,4-diphenyl-3-buten-2-one in three steps, incl. Grignard. HAZARD: benzene (carcinogen) - avoidable. See also Rivett, D.E.A., J. Chem. Educ. 57, 751 (1980).

***ORG ANAL CONSUMERPROD IR NATPROD UVIS 3 HAZARD**

Coffee, Tea, or ...Cocoa: a Trio of Experiments Including the Isolation of Theobromine from Cocoa

Pavia, D. L.

J. Chem. Educ. 50,791 (1973)

Isolation of theobromine by CHCl_3 extraction and conversion to caffeine with dimethyl sulfate. Hazards: CHCl_3 (carcinogen), pure caffeine (toxic), dimethyl sulfate (alkylating agent).

***ORG CHIRAL FREERAD PHOTO PREP 3 HAZARD**

An Easily Conducted Free Radical Substitution for Organic Chemistry Courses
Pavlis, R. R.

J. Chem. Educ. 59,658 (1982)

Photobromination of diphenylethane gives largely meso isomer. HAZARD: no mention of cautions in use of CCl_4 or in handling product (organic benzylic bromides may be toxic).

***ORG NOPROC PREP TECHNIQUE 3**

Basic Organic Laboratory Techniques and Problem Solving

Pearson, R. E.

J. Chem. Educ. 46,692 (1969)

Nitration of 4-nitrophenol is posed as a problem to students to prove reaction occurred. 4-Nitrophenol and 2,4-dinitrophenol have same mp. Recrystallization techniques developed.

***ORG CHIRAL ISOMERS NMR PREP PROOF 3**

Alpha- and Beta-D-Glucose Pentaacetate: An experiment in structure using nmr

Pearson, W. A.; Spessard, G. O.

J. Chem. Educ. 52,814 (1975)

For prep., refer: Mohrig & Neckers, Laboratory Experiments in Organic Chemistry, Van Nostrand, 1973.

***ORG PHYS KIN 3**

Solvolysis of 1-Haladamantanes

Perkins, R.

J. Chem. Educ. 56,208 (1979)

Varying halogen and temperature used in rate studies. See also Markgraf, J.F.; Anton, M.F., J. Chem. Educ. 54,733 (1977).

***ORG PREP REDOX 3 HAZARD**

Synthesis of Benzoic Acid Using Household Bleach

Perkins, R.

J. Chem. Educ. 61,5511(1984)

The procedure to conveniently oxidize acetophenone to benzoic acid is described. Chloroform (carcinogenic HAZARD, not described) is an additional product.

***ORG ANAL PHYS ESR FREERAD KIN PHOTO PREP 4**

Radical Recombination Kinetics: An experiment in physical organic chemistry
Pickering, M.

J. Chem. Educ. 57,833 (1980)

Detailed presentation of a nice integrated experiment. The purple triphenylimidazolyl radical is formed by dissolution of the dimer (prep. given) in aromatic solvents. Recombination in the dark gives rise to another dimer. The reaction rates can be studied spectrophotometrically (Spec 20). Proof that the purple species is a dimer via ESR studies.

***ORG NAME PREP 3 HAZARD**

The Eschweiler-Clark Methylation of Amines: An organic chemistry experiment.

Pine, S. H.

J. Chem. Educ. 45,118 (1968)

Benzylamine forms tert. amine in easy prep. HAZARD: formaldehyde is low grade (?) carcinogen.

***ORG NATPROD TECHNIQUE 3**

An Industrial Steam Distillation: Separation of Rosin and Turpentine From Pine Gum

Potter, F. S.; Schuerch, C.

J. Chem. Educ. 52,672 (1975)

100 g. crude pine gum per student, steam dist'n at 200 deg.

***ORG MASSPEC NMR PREP UVIS 3**

Isomer Analysis by Spectral Methods

Poulton, G. A.

J. Chem. Educ. 52,397 (1975)

Pseudo-ionone, prepared from citral, is isomerized to a mixture of alpha- and beta-ionone, analyzed by spectroscopic methods.

***ORG PREP 3 HAZARD**

Esterification for the Introductory Organic Laboratory Course:

A modified Dean-Stark trap

Puterbaugh, W. H.; Vanselow, C. H.; Nelson, K.; Shrawder, E. J.

J. Chem. Educ. 40,349 (1963)

Azeotropic removal of water using a simple Dean-Stark trap (can be made by simple glassblowing). HAZARD: benzene, a carcinogen, is chief solvent recommended.

***ORG PREP QUAL REARRANGE 3 4**

A Quick and Simple Conversion of Carboxylic Acids into Their Anilides of Heating with Phenyl Isothiocyanate

Ram, N. R.; Kumar, P.; Mukerjee, A. K.

J. Chem. Educ. 60,508 (1983)

An improved & advantageous method of obtaining anilides from carboxylic acids by method in title. Mtd is also applicable to hydroxy,phenolic, and malonic acids. 18 mpts given. WARNING: avoid benzene, a carcinogen.

***ORG PREP QUAL 3**

S-Benzylthiuronium Bicarbonate for the Derivatization of Carboxylic Acids

Reddy, J. V. K.; Boparai, K. S.

J. Chem. Educ. 52,324 (1975)

Prep. method for S-benzylthiuronium bicarbonate from the chloride, and its use in preparation of solid derivatives for characterization of carboxylic acids.

***ORG FREERAD GC PREP 4**

Inductive Effects in The Chlorination of 1-Chlorobutane: An organic laboratory experiment

Reeves, P. C.

J. Chem. Educ. 48,636 (1971)

SO₂Cl₂ and isobutyronitrile give mixture of products analyzed by gc.

***ORG PREP PTC SUBST.RXN 3 HAZARD**

Nucleophilic Substitution by Phase Transfer Catalysis

Reeves, W. P.; White, M. R.; Bier, D.

J. Chem. Educ. 55,56 (1978)

Prepn of alkyl thiocyanates from the halides + KSCN using a PTC. Example procedure uses n-butyl bromide in the presence of tetrabutyl ammonium bromide. HAZARD: severe skin irritants and lachrymators.

***ORG PREP 3**

Preparation of Acetanilide from Nitrobenzene

Reeve, W.; Lowe, V. C.

J. Chem. Educ. 56,488 (1979)

Improved method; 1 lab period. Reduce the nitrobenzene with Fe/HCl, filter, and acetylate the chilled aniline-water mixture with acetic anhydride. The acetanilide precipitates and is purified by recrystallization from water. Detailed instructions.

***ORG PHYS DEMO KIN PH 2**

Flashy Solutions

Riley, J. T.

J. Chem. Educ. 54,29 (1977)

Hydrolysis of t-butyl chloride and t-butyl bromide in the presence of universal indicator produces a sequence of colours in reaction mixture. A tested demonstration.

***ORG DEMO PREP 3**

Synthesis of an Azo Dye as a Lecture Demonstration

Robertson, G. R.

J. Chem. Educ. 34,566 (1957)

Preparation of phenyl-azo-beta-naphthol from aniline + beta-naphthol. Explicit directions.

***ORG POLYMER PREP 3 HAZARD**

Preparation of Terephthaloyl Chloride: Prelude to Ersatz Nylon

Rose, N. C.

J. Chem. Educ. 44,283 (1967)

Reaction with piperazine in nylon rope trick. HAZARD: PC15 (toxic, corrosive); CCl₄ (carcinogen), avoidable.

***ORG PREP 3 HAZARD**

Hydration of an Alkyne: Undergraduate Organic Chemistry Experiment

Rose, N. C.

J. Chem. Educ. 43,324 (1966)

2-Methyl-3-butyn-2-ol hydrated to ketone. One period. HAZARD: benzene, carcinogen, can be avoided.

*ORG PREP SEQ 3 HAZARD

Preparation of 6-Aminosaccharin: A Multistep Synthesis

Rose, N. C.; Rome, S.

J. Chem. Educ. 47, 649 (1970)

p-Nitrotoluene to product in three or four steps. HAZARD: CISO₃H.

*ORG IR NATPROD PREP SEQ 4

Conversion of (+)-Limonene to (-)-Carvone: An organic laboratory sequence of local interest

Rothenberger, O. S.; Krasnoff, S. B.; Rollins, R. B.

J. Chem. Educ. 57, 741 (1980)

Limonene extracted from orange skins is converted in 3 chemical steps to (-) carvone. Overall 9 hours needed.

*ORG NAME PREP PTC 3

The Preparation of p-Cresyl Propyl Ether by Phase Transfer Catalysis

Rowe, J. E.

J. Chem. Educ. 57, 162 (1980)

Note describes Williamson ether synthesis using a quaternary ammonium bromide catalyst. Requires use of heater-stirrer, and vacuum distillation.

*ORG CHIRAL NMR REDOX SEQ 3

The Determination of the Stereochemistry of Erythro-1,2-Diphenyl-1,2-Ethanediol: An Undergraduate Organic Experiment

Rowland, A. T.

J. Chem. Educ. 60, 1084 (1983)

Benzoin is reduced by sodium borohydride to one of the stereoisomers of 1,2-diphenyl-1,2-ethanediol; this is converted to its acetone. Product identification by NMR establishes structure of title cpd. Straightforward.

*ORG IR MASSPEC NMR PREP 3

The Effects of Aryl Substituents on IR, NMR, and Mass Spectra of N-t-Butylbenzamides

Rubottom, G. M.

J. Chem. Educ. 51, 616 (1974)

Variation of aryl chloride in reaction with t-butyl amine gives solids purified by vacuum sublimation. Students measure and analyze substituent effects.

*ORG ANAL COLUMNC NATPROD NOPROC PROJ SEPARATION 3 4

The Essential Oils: A series of laboratory experiments

Runquist, O.

J. Chem. Educ. 46, 846 (1969)

Individual or pair work to purify (vac. dist'n and column chromatog.), hydrolyze, and identify components of (inexpensive) oils. Lit. work req. Highly recommended. Characterization by ir, nmr, gc, etc.

*ORG ANAL COLUMNC PREP TLC 2 3

Column and Thin-Layer Chromatography

Ruppel, I. B., Jr.; Cuneo, F. L.; Krause, J. G.

J. Chem. Educ. 48, 635 (1971)

Nitration of phenol; products separated on column, checked TLC. HAZARD: phenol.

*ORG DIST HPLC MASSPEC NATPROD NMR PROJ VACTEK 4

Separation and Analysis of Citral Isomers

An Undergraduate Organic Laboratory Experiment

Sacks, J.; Greenley, E.; Leo, G.; Willey, P.; Gallis, D.

Mangravite, J. A.

J. Chem. Educ. 60, 434 (1983)

Combined techniques experiment based on the well-known sepn and analysis of citral isomers from lemon grass oil. 3 lab periods.

*ORG NMR 3

NMR Hammett Correlation: A laboratory experiment

Salmon, M.; Jimenez, A.; Salazar, I.; Zawadzki, R.

J. Chem. Educ. 50, 370 (1973)

NMR spectra of a series of substituted benzaldehydes measured. Shift of aldehyde H correlates with Hammett sigma.

*ORG DIELSALDER PREP 3

3-Sulfolene: A Butadiene Source For a Diels-Alder Synthesis: An undergraduate laboratory experiment

Sample, T. E., Jr.; Hatch, L. F.

J. Chem. Educ. 45, 55 (1968)

Maleic anhydride reacts w. 3-sulfolene (ie, 2,5-dihydrothiophene-1,1-dioxide) eliminating SO₂. Product is called endo-cis-4-cyclohexene-1,2-carboxylic anhydride; however, while the intermediary is endo-, the final product is not. Suggested extensions. HAZARD (avoidable): benzene.

***ORG COURSE GC IR PROJ 3**

A Laboratory Exercise for Organic Chemistry

Sands, R. D.

J. Chem. Educ. 52,732 (1975)

First semester organic lab. begins with fractional dist. separation of mixture of two unknowns, an alcohol and a ketone, monitored by gc. Each student does four preparations from the (separated) unknown mix.

***ORG ANAL GRAVIM STOICH 2 HAZARD**

A General Chemistry Experiment on Clathrates

Sawyer, A. K.

J. Chem. Educ. 41,661 (1964)

Hydroquinone clathrates of CH_3OH , H_2S , molecular ratio determined gravimetrically. Stony Brook uses prep. of the methanol clathrate to teach analytical balance - weigh prepn every week for 6 weeks. We consider the H_2S clathrate too dangerous (toxic hazard).

***ORG FREERAD GC PHOTO VACTEK 4**

The Gas Phase Free Radical Halogenation of Hydrocarbons: An undergraduate experiment

Scala, A. A.

J. Chem. Educ. 49,573 (1972)

Reactions in small sealed tubes, filled on vac. system. Analysis by gc.

***ORG PREP 3**

The Synthesis of 2-Nitroresorcinol: An Experiment With Sulfonic Acids

Schaffrath, R. E.

J. Chem. Educ. 47,224 (1970)

Illustrates sulfonation to block a reaction site. One period. We (RPI) have repeated expt. Product is not stable.

***ORG GC ORGANOMETAL PREP 4**

Reaction of Organocopper Intermediates: An Undergraduate Laboratory Experiment

Schambach, R. A.

J. Chem. Educ. 53,735 (1976)

Chemistry of ortho-nitrophenylcopper investigated by systematically varying starting conditions of the copper-quinoline decarboxylation of ortho-nitrobenzoic acid. Prep of cupric nitrobenzoate given, plus decarboxylation procedure. Extensions suggested.

***ORG FRIEDEL.CRAFTS IR NMR PREP 3**

Friedel-Crafts Acylation. An experiment incorporating spectroscopic structure determination

Schatz, P. F.

J. Chem. Educ. 56,480 (1979)

Procedure given for acylation (acetyl chloride) of 9 aromatic compounds, used as starting materials, and bpts of product ketones. Student prepares one ketone and identifies it unambiguously by IR, NMR spectroscopy.

***ORG NATPROD PREP SEQ 3 4**

Synthesis of Chrysanthemic Acid: A multistep organic synthesis for undergraduate students

Schatz, P. F.

J. Chem. Educ. 55,465 (1978)

6 lab periods. Starting materials: 3-methyl-2-butenic acid and 2-methyl-3-buten-2-ol. Five-step convergent synthesis. High vac. dist'n.

***ORG GC NOPROC PREP 3**

Alkylation of Methyl Acetoacetate and Gas Chromatographic Analysis of Products

Schimelpfenig, C. W.

J. Chem. Educ. 54,446 (1977)

A much more rapid procedure than that of the traditional experiment. Starting reagents are methanol, sodium methoxide, methyl acetoacetate, and bromoethane. "Spiking" technique in gc analysis. Procedure outlined available from author.

***ORG HETEROCYCLIC PREP 3**

Laboratory Synthesis of a Heterocyclic Compound

Schimelpfenig, C. W.

J. Chem. Educ. 36,570 (1959)

Prep'n of benzofuran oxide by oxidation of o-nitroaniline in alcoholic KOH.

***ORG DEMO DIELS.ALDER 2 HAZARD**

The Diels-Alder Reaction

Schimelpfenig, C. W.

J. Chem. Educ. 36, A37 (1959)

A Chem-Ed Tested Demo. Anthracene + tetracyanoethylene, both in benzene sol'n. HAZARD: carcinogens (benzene, anthracene).

***ORG ANAL GC 3**

A Gas Chromatographic Analysis for the Elementary Organic Laboratory
Schimelpfenig, C. W.

J. Chem. Educ. 39, 310 (1962)

Alkenes from sulfuric acid dehydration of tert. pentyl alcohol distilled, analyzed. Dow 11 silicone on fire-brick column.

***ORG IR NMR TECHNIQUE 3**

Vacuum Distillation Experiment

Schoffstall, A. M.; Specht, J. D.

J. Chem. Educ. 47, 539 (1970)

Unknown mix is distilled at reduced pressure, identify products by ir, nmr. Uses no fract. column, but 0.1 to 2.0 mm (maybe higher pressure OK?).

***ORG NAME PREP 3 HAZARD**

The Hofmann Amide Rearrangement

Schreck, J. O.

J. Chem. Educ. 45, 670 (1968)

Benzamide reacts to form aniline. Possible intermediates: N-bromobenzamide and phenylisocyanate, are prepared and shown also to give aniline. HAZARD: chloroform is a carcinogen; phenyl isocyanate a persistent lachrymator.

***ORG HETEROCYCLIC PHOTO PREP SEQ 3**

A Photochemical Preparation of Indoles

Schultz, A. G.; Kane, V.

J. Chem. Educ. 56, 555 (1979)

Reaction sequence. Starting materials are N-methylaniline and ethyl 2-chloroacetate. Final product is ethyl 3-methyl-(N-methylindole)-2-carboxylate. 275 watt sunlamp.

***ORG CARBENE CATAL COLUMNC PREP 3 HAZARD**

Basic Alumina: Source of Dihalocarbenes

Serratos, F.

J. Chem. Educ. 41, 564 (1964)

Col. chrom. prep. of 7,7-dihalobicyclo(4.1.0)heptane from cyclohexene and haloform. HAZARD: haloforms are carcinogens.

***ORG PREP 3 HAZARD**

Amides and Hydrazides From Amine and Hydrazine Hydrochlorides

Shama, S. A.; Tran, T. L.

J. Chem. Educ. 55, 816 (1978)

Acid chloride reacts with amine salts, producing HCl. HAZARD: hydrazines are toxic, possibly carcinogens.

***ORG COLOR PREP 3 HAZARD**

New Vat-Dyes Suitable for Student Experiments

Shapiro, R.; Sugerman, G.; Rachbach, H.; Wagreich, H.

J. Chem. Educ. 37, 526 (1960)

o-Benzoquinone (in situ from catechol oxidation) reacts with aryl amines to form dyes, used to dye wool. Many amines used, so suitable for projects lab. Intermediates investigated chromatog. Dye colors are mixes. HAZARD: aryl amines are potential carcinogens.

***ORG ANAL APPARATUS QUAL 3**

The Qualitative Detection of Olefins by Ozonolysis

Sharefkin, J. G.; Ribner, A.

J. Chem. Educ. 37, 296 (1960)

The suspected olefin is dissolved in a 0.05M 2,4-dinitrophenylhydrazine/2M HCl/methanol solution. Ozonized air is then passed through, and the solution tested with alcoholic KOH. The positive test is a deep red color. The main thrust of the paper is the construction of the ozonizer, especially the capacitor assembly. Caution: shock hazard.

***ORG ORG DIELSALDER PREP 3 HAZARD**

A Diels-Alder Reaction Experiment

Sheppard, W. J.

J. Chem. Educ. 40, 40 (1963)

Endo-bicyclo(2.2.1)hept-5-ene-2,3-dicarboxylic anhydride from cyclopentadiene (from depolymerization of dimer) and maleic anhydride. HAZARD: benzene, carcinogen, avoidable; maleic anhydride, toxic; cyclopentadiene, irritant odor.

***ORG PHYS CATAL DEMO KIN PREP 3**

Demonstrating Acid Catalysis: Preparation of 2,4-dinitrophenylhydrazones

Shine, H. J.

J. Chem. Educ. 36, 575 (1959)

Into each of 2 small flasks is pipetted 0.2 ml of benzaldehyde and 5 ml of 2,4-dinitrophenylhydrazine sol'n. No reaction is apparent until a drop of HCl is added to one flask. (The other is subsequently acidified with HOAc.)

***ORG CYCLOADDITION PREP PROJ 4**

Project For a Problem-Oriented Undergraduate Organic or Integrated Undergraduate Laboratory

Silveira, A., Jr.

J. Chem. Educ. 55, 57 (1978)

Several beta-keto esters converted to monoalkyl derivatives, then to 2-pyrazolin-5-ones, and chlorinated. Base treatment gave unsat'd acids. Extensions. About six weeks. Characterization: nmr, ir, gc.

***ORG ANAL INORG NMR ORGANOMETAL 4 HAZARD**

NMR Determination of n-Butyllithium

Silveira, A., Jr.; Bretherick, H. D., Jr.; Negishi, E-I.

J. Chem. Educ. 56, 560 (1979)

Determination of n-butyllithium in hexane using benzene as an internal standard. HAZARDS: fire hazards; carcinogen.

***ORG IR NMR PREP PROOF 3**

The Reaction Between a Vinylic Ether and 2,4-Dinitrobenzenesulfonyl chloride

Silversmith, E. F.

J. Chem. Educ. 56, 127 (1979)

Dihydropyran addition, product structure determined by nmr, ir. Two periods - don't let students read article.

***ORG GEOM HEAT IR ISOMERS PHOTO 3**

Photochemical and Thermal Interconversion of Cis and Trans Isomers:

An organic laboratory experiment

Silversmith, E. F.

J. Chem. Educ. 50, 568 (1973)

Trans-1,4-diphenyl-2-butene-1,4-dione. 275-Watt sunlamp. Shorter version (part of) Pasto, D.J., J. Chem. Educ. 51, 277 (1974).

***ORG ADDITION GEOM NMR PREP 4**

The Problem of Syn- Versus Anti-Addition: An organic chemistry laboratory experiment

Silversmith, E. F.

J. Chem. Educ. 59, 346 (1982)

Addition of 2,4-dinitrobenzenesulfonyl chloride to acenaphthylene to give a product where student must determine by NMR whether the addition proceeds syn- or anti-. Complete directions.

***ORG GC IR 3 HAZARD**

Verification of Saytzeff's Rule: An integrated experiment for the first-year student

Skinner, A. C.; Davis, J.

J. Chem. Educ. 48, 653 (1971)

2-Butanol and hot conc. sulfuric acid or 2-bromobutane and alc. KOH. Gas samples for gc, ir; analyze mix prod. HAZARD: hot conc. H₂SO₄.

***ORG PHYS DEMO LUMIN PHOTO 3 HAZARD**

A Chemiluminescence Reaction

Slabaugh, W. H.

J. Chem. Educ. 47, 522 (1970)

Oxidation of the vat dye violanthrone in CHCl₃-H₂O₂-NaOH by chlorine.

Needs fume hood.

HAZARDS: CHCl₃ (carcinogen); 30% H₂O₂, Cl₂ (strong oxidants).

***ORG COLOR COMPLEX DEMO 3**

A Simple Lecture Demonstration of Aromatic Nucleophilic Substitution

Smith, N. H. P.

J. Chem. Educ. 52, 238 (1975)

Reaction of 5 substituted nitrobenzenes with alkoxide in DMF, DMSO, EtOH, develops color (sigma-bonded complexes).

***ORG COLOR DEMO 2 3 HAZARD**

A Rapid and Convenient Lecture Demonstration of Dyeing With Azo Compounds

Smith, N. H. P.

J. Chem. Educ. 50, 790 (1973)

Nitroanilines diazotized, coupled with various naphthols impregnated on cotton fabric. Old demo (Fieser) but some coupling components are new.

HAZARD: one suggested diazo, a benzidine derivative is likely carcinogenic.

***ORG FRIEDEL-CRAFTS IR PREP STATISTICS 3 HAZARD**

Factorial Design in Undergraduate Organic Experiments

Smith, R. B.; Billingham, E. J., Jr.

J. Chem. Educ. 45, 113 (1968)

Isomer distribution in 2-bromobutane-benzene reaction studied by quantitative ir. HAZARD: benzene is a carcinogen, substitute. Temp., amount of catalyst varied.

***ORG PREP 3 HAZARD**

Preparation of P-Anisonitrile

Smith, R. F.; Bates, A. C.

J. Chem. Educ. 46,174 (1969)

p-Anisaldehyde, dimethylhydrazine reacted; resulting hydrazone is treated with a base to yield product. One period. HAZARD: N,N-dimethylhydrazine is a carcinogen.

***ORG PREP 3 HAZARD**

A Student Preparation of Butyl Ether

Smith, W. B.

J. Chem. Educ. 39,212 (1962)

Prep'n from 1-butanol by sulfuric acid cat., azeotrope water (some complicated azeotropes). HAZARD: ethers form explosive peroxides on standing - can be a distillation hazard.

***ORG ANAL NMR 4**

Quantitative Analysis Using NMR

Smith, W. B.

J. Chem. Educ. 41,97 (1964)

Determination of enol content, deuterium exchange, percent hydrogen in unknowns. Uses A-60; better techniques now available.

***ORG QUAL 3**

Calcium Oxide-Zinc Fusion: The Successor to Sodium Fusion in the Undergraduate Laboratory

Snyder, C. H.; Sickels, J. P.; Delvalle, C. J.

J. Chem. Educ. 50,72 (1973)

Directions for liquid and solid samples. Caution: occasional vigorous reaction.

***ORG FREERAD PREP 3 HAZARD**

The Preparation of 2,4,6-Tri-*t*-Butylphenol

Somers, B. G.; Cook, C. D.

J. Chem. Educ. 32,312 (1955)

Alkylation of phenol with isobutylene, oxidn. first gives colored free radical. HAZARD: Benzene (carcinogen), is avoidable.

***ORG ANAL NMR QUAL 3**

Studies for the Organic Qual Lab

Southam, R. M.

J. Chem. Educ. 53,34 (1976)

A set of unknowns to analyze for structure by degradation. For instructors eyes only - good practical problems.

***ORG ANAL PHYS COURSE INTEGR NOPROC PROJ 2**

A Unified Introductory Chemistry Laboratory

Spittgerber, A. G.; MacLean, D. B.; Neils, J.

J. Chem. Educ. 48,330 (1971)

A 14-week introductory lab beginning with preparation of an unknown organic acid and its subsequent identification in later experiments by m.p.t., Ksp of silver and copper salts, etc.

***ORG ADDITION DEMO PREP 1**

Cracking of Mineral Oil

Stowe, R. E.

J. Chem. Educ. 37,A54 (1960)

Bromine vapor is decolorized by vapors from boiling mineral oil. A Chem-Ed Tested Demo.

***ORG GC HISTORIC NAME NMR REARRANGE 4**

A Study of Stereospecificity

The Beckmann Rearrangement

Stradling, S. S.; Hornick, D.; Lee, J.; Riley, J.

J. Chem. Educ. 60,502 (1984)

Benzyl methyl ketone is converted to its E and Z oxime isomers. The mixture is stereospecifically rearranged to N-benzylacetamide and N-methyl-2-phenylacetamide, resp., with P2O5-methanesulfonic acid reagent. Oxime, amide mixtures analyzed by NMR, parameters given; GC gives ratio of amides.

***ORG PREP 3**

Aniline by a Modified Jones Reductor Method

Stubbs, U. S., Jr.; Atkins, C. F.

J. Chem. Educ. 36,611 (1959)

Modification of standard organic preparative reaction, to give continuous reduction.

***ORG INORG COMPUTER IR NMR PREP TECHNIQUE 5 HAZARD**

Preparation and NMR Analysis of a Silylthiocarbamate:

An Advanced Laboratory Project

Suydam, F. H.; Yoder, C. H.

J. Chem. Educ. 48,849 (1971)

Advanced synthetic techniques lead to a product identified ir, nmr. Variable temp nmr on this. Hazard: Toxic and carcinogenic: COS, ethyl chloroformate, thioacetamide, trimethylchlorosilane.

***ORG GC PREP 3**

Dehydration of 2-Methylcyclohexanol

Taber, R. L.; Champion, W. C.

J. Chem. Educ. 44,620 (1967)

Dehydrant = 85% phosphoric Acid, analyze product by gc.

***ORG FLUOR HETEROCYCLIC INTEGR PREP PROJ RADIOCHEM 5 HAZARD**

Ultraviolet and Fluorescent Spectra of 2,5-Diaryl-1,3,4-Oxadiazoles

Taber, R. L.; Grantham, G. D.

J. Chem. Educ. 47,834 (1970)

Prepn of a series of 11 substituted 2,5-diaryl-1,3,4-oxadiazoles, and characterization by TLC, fluorescence spectra, etc. Products can be used in a liquid scintillation counter. HAZARDS: benzene (use something else); acidification of sodium azide (storage hazard) yields hydrazoic acid, not noted as hazardous in the article.

***ORG GC 3**

The Dehydration of 3,3-Dimethyl-2-Butanol

Taber, R. L.; Grantham, G. D.; Champion, W. C.

J. Chem. Educ. 46,849 (1969)

Product mix is analyzed by gc. Good discussion.

***ORG CHIRAL COMPLEX DEMO 3**

A Demonstration of Stereoselectivity

Tapscott, R. E.

J. Chem. Educ. 51,586 (1974)

Formation of vanadyl-tartrate complexes. The dextrorotary, racemic and meso complexes have markedly different colors in alkaline solution.

***ORG ADDITION PESTICIDE PREP PROJ 3 HAZARD**

Synthesis and Testing of the Insecticide Carbaryl; A Laboratory Experiment

Thadeo, P. F.; Mowery, D. F.

J. Chem. Educ. 61,742 (1984)

The preparation of Carbaryl (1-naphthylN-methylcarbamate) from methyl isocyanate (lachrymator, of Bhopal notoriety) requires only one two-hour period. Testing of carbaryl with fruit flies is described, as well as extensions of the experiment to prepare and test similar carbamates.

***ORG ADDITION BIOCHEM HPLC NATPROD PREP TLC UVIS VITAMIN 4**

Synthesis of Vitamin K Epoxide; An Undergraduate Biochemistry Experiment

Thierry-Palmer, M.

J. Chem. Educ. 61,179 (1984)

The title compound is prepared from Vitamin K by reaction with hydrogen peroxide in semidarkness; isolated by extraction with hexane and purified by reversed phase TLC. Separations and purifications are monitored by UV; the side products are analyzed by HPLC. Requires 3 four-hour labs.

***ORG ANAL QUAL 3**

Acids as Derivatives of Aldehydes Prepared with Silver Oxides

Thomason, S. C.; Kubler, D. G.

J. Chem. Educ. 45,546 (1968)

Simple modification of aldehyde oxidation to acid.

***ORG GC IR 3**

Separation and IR Analysis of a Mixture of Organic Compounds

Thompson, E. M.; Almy, J.

J. Chem. Educ. 59,617 (1982)

Fractional distillation and gas-liquid chromatography. One lab period. Artificial mixtures of common lab alcohols, amines, etc.

***ORG IR ISOTOPE NAME PREP 3 HAZARD**

The Synthesis and Nitration of Benzene-d(1)

Todd, D.

J. Chem. Educ. 50,366 (1973)

Phenylmagnesium bromide + D2O, followed by formation of dinitroderivative. Questions. HAZARD: Author says benzene (obviously) unavoidable; take precautions against a carcinogen. The author is one of the Readers.

*ORG PHYS INTEGR KIN PREP TLC UVIS 3 HAZARD

A Laboratory Project in Competitive Aromatic Nucleophilic Displacement
Todd, D.; Lookabaugh, M.
J. Chem. Educ. 49,292 (1972)
2,4-Dinitrochlorobenzene reacted with a mixture of aniline + p-anisidine to detn. relative reactivity. Mixed product isolated, separated by tlc and analyzed by abs. spectrophotometry at 360 nm. Integrated.
Hazard: 2,4-DNB is a bad skin irritant.

*ORG ANAL ADDITION NMR QUANT 3

Isobutylene Revisited: An Experiment Introducing Both Qualitative and Quantitative Application of NMR Spectroscopy
Tremelling, M. J.; Hammond, C. N.
J. Chem. Educ. 59,697 (1982)
Short note describes analysis of product mixture from dimerization of isobutylene (procedure by reference) by NMR spectroscopy.

*ORG ANAL PHYS HITEMP 4 HAZARD

CCl₄-reactions at High Temperatures: Illustration of Steric Effects Using Atomic Models
Tsuge, S.; Leary, J. J.; Isenhour, T. L.
J. Chem. Educ. 51,266 (1974)
Pyrolysis of CCl₄ (HAZARD) in sealed tubes. Reaction products include CCl₂, C₂Cl₆ and C₆Cl₆. Suggested extensions include GC, etc.

*ORG FREERAD NMR PREP SEQ SUBST.RXN 4 HAZARD

Free-Radical Bromination of p-Toluic Acid: An Experiment in Organic Chemistry
Tuleen, D. L.; Hess, B. A., Jr.
J. Chem. Educ. 48,476 (1971)
N-bromosuccinimide bromination (uses spec. glassware but can substitute), then three nucleophilic substit. prod. HAZARD: Benzoyl peroxide, explosive; CCl₄, carcinogen, is avoidable. See Olsen, E.S., J. Chem. Ed., 57, 157 (1980) for a modification.

*ORG DISTRIB ENVIRON NOPROC TITN 2

The Determination of 1-Octanol/Water Partition Ratios:
An Organic Chemistry Laboratory Experiment
Umland, J. B.
J. Chem. Educ. 60,1081(1983)
Short note recommends use of 1-octanol/water system in studying partition of carboxylic acids as interesting to the student because of role in environmental studies. No procedure; analysis by NaOH titration.

*ORG NOPROC PHOTO PROJ QUAL 3

A Combined Photochemistry, Organic Qualitative Analysis Experiment
VanDeMark, M. R. R.; Kumler, P. L.
J. Chem. Educ. 50,512 (1973)
Photo-oxidation of cyclopentanol, in the presence of iodine and HgO. Students should not know the answer before doing the project.

*ORG CATAL PREP 3

Catalytic Dehydrogenation of Tetrahydrocarbazole
VanVerth, J. E.; Ulmer, S. W.
J. Chem. Educ. 54,383 (1977)
5% Palladium-on-carbon catalyst. Warning: high-boiling impurities in reactants will poison catalyst. 1 lab period. Caution: some H₂ maybe emitted.

*ORG PHYS CALORIMETRY REARRANGE THERMO 3

A Direct Calorimetric Demonstration of Resonance Energy in The Benzene Nucleus
VanVugt, W. H.; Mosselmann, C.
J. Chem. Educ. 52,746 (1975)
Dewar flask and 0.1 deg. thermometer used to measure heat of rearrangement of 3,5-cyclohexadiene-1,2-dicarboxylic acid to phthalic or benzoic acid and 2-cyclohexene-1,2-dicarboxylic acid. Information sheet available.

*ORG DIELS.ALDER PREP 3 HAZARD

Two Syntheses for the Organic Undergraduate
Vaughn-Williams, H. R.
J. Chem. Educ. 48,259 (1971)
Products are 3,4-phenanthrene(9.10)2,5-diphenylcyclopentadione, and then 4,5-phenanthrene(9.10)3,6-diphenyldihydrophthalic acid by Diels-Alder reaction, from phenanthroquinone, dibenzyl ketone, maleic anhydride.
HAZARD: toxic chemicals, especially maleic anhydride.

*ORG PREP 3 HAZARD

An Improved Synthesis of 2-Bromonaphthalene
Vingello, F. A.; Delia, T. J.; Polss, P.; Farrier, D.
J. Chem. Educ. 40,544 (1963)
Three methods; only one recommended is diazotization with CuBr/HBr of 2-naphthylamine-1-sulfonic acid. Do not use prepn. from 2-naphthylamine, a powerful carcinogen (HAZARD).

***ORG ANAL IR SEPARATION**

Hydrolysis of Latex Paint in Dimethylsulfoxide: An organic laboratory experiment
Vinson, J. A.
J. Chem. Educ. 46,877 (1969)
Alkaline hydrolysis and steam distillation to isolate and identify alcohol by ir (could also be nmr or gc and b.p.). Micro boiling point apparatus.

***ORG ANAL QUAL 3**

Organic Qualitative Analysis: An improved sodium fusion and a new test for N and S
Vinson, J. A.; Grabowski, W. T.
J. Chem. Educ. 54,187 (1977)
Na/Pb alloy for Na fusion; p-nitrobenzaldehyde color test for cyanide and sulfide ion.

***ORG ANAL ACBA ASPIRIN CONSUMERPROD TITN 2 3**

Saponification of Aspirin with Dimethylsulfoxide
Vinson, J. A.; Hocker, E. K.
J. Chem. Educ. 46,245 (1969)
Rapid saponification. CAUTION: DMSO absorbed thru skin, carries dirt, etc.

***ORG PREP 3**

The Small Scale Preparation of Azobenzene and Hydrazobenzene
Vogel, A. I.; Wading, A.; Wading, J.
J. Chem. Educ. 35,40 (1958)
Mg reduction of nitrobenzene to azobenzene and (with excess Mg) to hydrazobenzene. Simple, one period.

***ORG PREP 3**

The Small Scale Preparation of Azobenzene and of Hydrazobenzene
Vogel, A. I.; Wading, A.; Wading, J.
J. Chem. Educ. 35,40 (1958)
Azobenzene by reaction of nitrobenzene with magnesium and methanol. Hydrazobenzene by reduction with excess magnesium or with Devarda's alloy.

***ORG CONSUMERPROD PHARM 3**

Drugs in the Chemistry Laboratory. The Conversion of Acetaminophen into Phenacetin
Volker, E. J.; Pride, E.; Hough, C.
J. Chem. Educ. 56,831 (1979)
Acetaminophen (N-acetyl-p-aminophenol) is alkylated with ethyl iodide using K₂CO₃ as a basic catalyst. Starting material Datril, etc. or reagent grade acetaminophen. Explicit instructions.

***ORG PHYS CATAL KIN TAUTOMERS UVIS 3**

The General Base Catalyzed Enolization of Acetone: An undergraduate kinetics experiment
Waddington, M. D.; Meany, J. E.
J. Chem. Educ. 55,60 (1978)
Within the capacity of most second-semester freshmen but organic mechanism studies are more advanced. Iodination of acetone is followed at 353 nm.

***ORG ANAL COLUMNC GELC ORGANOMETAL PREP 3 HAZARD**

An Illustrative and Inexpensive Column Chromatography Experiment
Wade, L. G., Jr.
J. Chem. Educ. 55,208 (1978)
Ferrocene and acetyl ferrocene are separated on a silica gel column using chloroform (HAZARD: carcinogen) as the moving phase. Prepn. of acetyl ferrocene given. One 5-hr lab period.

***ORG INORG COURSE IONX TECHNIQUE 1 2**

Laboratory Experiments for the Introductory Chemistry Course
Walter, R. I.
J. Chem. Educ. 45,672 (1968)
A collection of simple exp'ts, most not new. Includes recrystallization, distillation, oxidation (isopropyl alcohol to acetone, dimethyl maleate to fumarate), ion exchange (separation of iron, cobalt, and nickel).

***ORG COLUMNC CONSUMERPROD PREP 3**

An Interesting and Successful Organic Experiment
Wang, B. J.-S.
J. Chem. Educ. 51,631 (1974)
Reports successful use of prepn. of insect repellent N,N-diethyl-m-toluamide from m-toluic acid, thionyl chloride, diethylamine. Vac. distillation.

***ORG ANAL PHYS KEQ TAUTOMERS 3 HAZARD**

Keto-Enol Tautomerism of Ethyl Acetoacetate Experiment in Homogeneous Equilibrium
Ward, C. H.
J. Chem. Educ. 39,95 (1962)
Bromine addition to enol is rapid. Add xs bromine to keto-enol system, followed by addition of more than enough beta-naphthol to destroy remaining Br₂. Then det'n bromoester by adding xs KI and titrate liberated I₂ with std. thiosulfate. HAZARD: Br₂.

***ORG KIN SUBST.RXN 3 HAZARD**

Bromination of Alkanes
Warkentin, J.
J. Chem. Educ. 43,331 (1966)
Relative reaction rates with Br₂ in CCl₄ (HAZARD: carcinogen) of alicyclic and arylalkyl hydrocarbons. Simple apparatus. HAZARD: Br₂, CCl₄, etc.

***ORG GC SUBST.RXN 3**

Nucleophilic Substitution Reactions: Modifications and an Extension
Warren, H. W.; Newton, T. A.
J. Chem. Educ. 57,747 (1980)
Reactivity of butyl alcohols and butyl halides in substitution reactions measured by quantitative gc. Very short preparatory work followed by later gc.

***ORG ADDITION PREP 3**

A Hydration of an Alkyne Illustrating Steam and Vacuum Distillation
Wasacz, J. P.; Badding, V. G.
J. Chem. Educ. 59,694 (1982)
An "early" experiment: conversion of 2,5-dimethyl-3-hexyn-2,5-diol (prep. by ref.) to 2,2,5,5-tetramethyltetrahydrofuran-3-one (with mercuric sulfate). Can recycle mercuric sulfate sol'n.

***ORG PHARM PREP 3**

A Synthesis of Amphetamine
Wassink, B. H. G.; Duijndam, A.; Jansen, A. C. A.
J. Chem. Educ. 51,671 (1974)
From phenylacetone, ethanol, ammonia, aluminum grit and HgCl₂, 30 percent characterization data given. Warning: amphetamine is a controlled substance.

***ORG PROJ SEPARATION 2 3**

Isolation of Benzoic and Boric Acids From Listerine: An introductory organic chemistry experiment
Weichman, R. L.
J. Chem. Educ. 51,589 (1974)
Listerine is analyzed in 3-4 periods. Explicit directions. Characterizations by gc, ir, refractive index.

***ORG CHARGETRANS COMPLEX DEMO PREP 3**

A demonstration of charge-transfer complex formation using octachlorofulvalene
West, R.; Smith, R. M.
J. Chem. Educ. 50,723 (1973)
2-step prep of octachlorofulvalene from hexachlorocyclopentadiene. Pi-donors (such as pyridine) give intense colors (charge-transfer complex) with this compound in dilute solution.

***ORG COLOR DEMO PHOTO 3**

Conversion of Black and White Prints to Color in Daylight: A Demonstration Lecture
Wheeler, T. N.
J. Chem. Educ. 52,607 (1975)
Color film (exposed) is developed first in a black and white developer. Then converted to a full color print in the light, using N,N-dimethyl-p-phenylenediamine and three color couplers (cyan, magenta, yellow).

***ORG CATAL HEAT PREP THERMO 3**

The Ketene Generator: Simultaneous Exo-Endothermic Reactions.
Whitaker, R. D.; McGarian, T.
J. Chem. Educ. 53,776 (1976)
Ketene from acetone catalyzed by a hot copper coil will maintain the coil at red heat, although the reaction is known to be endothermic. Explanation is prob. oxidation of some acetone to CO₂ and H₂O. Caution: ventilation required. A Tested Demonstration.

***ORG NATPROD PHARM TLC 2 3**

Juglone: A Comparison of Natural and Synthetic Products
Wilbur, J. M.; Sublett, K. L.
J. Chem. Educ. 54,156 (1977)
Note on extraction of juglone from black walnuts, comparisons with synthetic product of Jesaitis and Krantz, J. Chem. Educ. 49, 436(1972) by tlc, m.p., pharmacological activity - demonstrated by sedation of goldfish.

***ORG PREP 2**

A Simplified Preparation of Anthraquinone

Wilcox, C. F., Jr.; Stevens, M.

J. Chem. Educ. 36,633 (1959)

Heat a solution of o-benzoylbenzoic acid in conc. sulfuric acid on a steam bath for 30 minutes.

***ORG CATAL PREP 3**

Hydrocinnamic Acid: Catalytic Hydrogenation for the undergraduate organic chemistry laboratory

Wilen, S. H.; Kremer, C. B.

J. Chem. Educ. 39,209 (1962)

Pd metal is catalyst for transfer hydrogenation - tetralin is dehydrogenated while cinnamic acid is hydrogenated. One period.

***ORG POLYMER PREP PROJ 3 HAZARD**

Polystyrene: A multistep synthesis

Wilen, S. H.; Kremer, C. B.; Waltcher, I.

J. Chem. Educ. 38,304 (1961)

Reaction series. Benzene is acetylated with acetic anhydride; the acetophenone is reduced with NaBH₄ to 1-phenylethanol. This is dehydrated to styrene with KHSO₄; the styrene is then polymerized by refluxing with dibenzoyl peroxide. Explicit directions. HAZARD: benzene.

***ORG PROJ TITN 3**

Cyclobutane Chemistry: A student laboratory experiment

Williams, F. T., Jr.; Baber, S. C.

J. Chem. Educ. 41,563 (1964)

Tetramethyl-1,3-cyclobutanedione (purchase or prep'n ref.) sublimation and conversion to diisopropyl ketone. Base titration of dione is like an ester.

***ORG ANAL HPLC 3**

Williams, J. M.

J. Chem. Educ. 58,1003(1981)

An addition to an organic prep. (tritycene). Variable wavelength UV detector (anthracene impurity absorbs at 250nm, but the fixed wavelength, 254nm detector may be adequate).

***ORG PHYS PHASE PREP 2 3**

The Absorption of Light by Oriented Molecules: An experiment in organic physical chemistry

Wilson, R. M.; Gardner, E. J.; Squire, R. H.

J. Chem. Educ. 50,94 (1973)

Prep. of a dye which has a long axis for alignment with liquid crystal (commercially avail. material). Color depends then on orientation with respect to polarized light.

***ORG PHYS INTEGR KIN PREP UVIS 3 HAZARD**

Fading of Bromphenol Blue: A combined synthesis and spectrophotometric kinetics experiment

Winans, R.; Brown, C. A.

J. Chem. Educ. 52,526 (1975)

Explicit directions for preparation of phenol red, bromphenol blue.

Rate of fading followed spectrophotometrically. HAZARDS: bromine, phenol.

***ORG PHYS DEMO LUMIN 1**

Chemiluminescence - Variations

Winkel, T. A.

J. Chem. Educ. 37,A73 (1960)

Luminol + hemoglobin + sodium perborate + trisodium phosphate + sugar.

A Chem-Ed Tested Demo.

***ORG NMR PREP 3**

Conversion of a Primary Alcohol to an Alkyl Halide Via a Tosylate Intermediate

Wiseman, P. A.; Betras, S.; Lindley, B.

J. Chem. Educ. 51,348 (1974)

3-Phenyl-1-propanol converted first to tosylate, then to chloride. Students use nmr to find what is happening.

***ORG HETEROCYCLIC PREP PROJ 3 HAZARD**

The Synthesis of Heterocyclic Compounds

Wolthius, E.

J. Chem. Educ. 56,343 (1979)

A good collection of experiments illustrating the preparation and reactions of N and O heterocyclic compounds. Starting materials are readily available reagents. HAZARD: some dangerous materials: phenylhydrazine.

*ORG CONSUMERPROD IR NMR PREP SUBST.RXN 2 HAZARD

p-Chlorophenoxyacetic Acid - Preparation of a Synthetic Plant Hormone
Wood, W. F.

J. Chem. Educ. 58,76 (1981)

Simple synthesis by nucleophilic displacement. Cautions are clearly stated.

*ORG APPARATUS PREP PROJ SUBST.RXN TECHNIQUE 4 HAZARD

Preparation of 4-Phenylbut-3-yn-2-one

Woollard, J. M.

J. Chem. Educ. 61,648 (1984)

The sodium salt of phenylethyne is prepared by reaction with sodium, then transferred (apparatus described) into acetic anhydride to produce the title compound, which is purified by vacuum distillation. Both phenylethyne and the title compound are lachrymators and vesicants. Suggestions for further reactions are given. HAZARD: toxic chemicals, sodium metal.

*ORG GC PREP 3 HAZARD

The Bromination of Anthracene

Wright, O. L.; Mura, L. E.

J. Chem. Educ. 43,150 (1966)

Bromination of anthracene or naphthalene, recryst. Detailed. HAZARD: bromine.

*ORG TLC 3

Demonstration of the Relative Nucleophilic Properties of Aromatic Primary Amines

Yeadon, A.

J. Chem. Educ. 48,256 (1971)

Reactions of a series of 5 aromatic amines with CH₃I followed by periodically withdrawing samples for TLC analysis. SiO₂ plates, I₂ staining. All relevant R_f's given. Not suitable for lecture demo. Relative reactivities estimated by noting the time for the reaction products to appear.

*ORG BIOCHEM GEOM NMR PREP SEQ 4 HAZARD

The Synthesis of a Dipeptide from its Component Amino Acids: Protecting Groups in the Elementary Organic Chemistry Laboratory

Young, P. E.; Campbell, A.

J. Chem. Educ. 59,701 (1982)

3-Step procedure: 1. the first amino acid (L-proline) is protected by acetylation, 2. the carboxyl group of the second, L-phenylalanine, is protected by conversion to the methyl ester (uses thionyl chloride), 3. the two are then coupled by the mixed anhydride method. Detailed procedure. No hazard analysis. HAZARD: the solvent used is chloroform, and the procedure calls for a CCl₄-dry ice bath. Conformational (E-Z) isomerism meas. by NMR.

*ORG GRIGNARD PREP 3 HAZARD

An Organic Experiment to Illustrate Thermodynamic Versus Kinetic Control

Youssef, A. K.; Ogliaruso, M. A.

J. Chem. Educ. 52,473 (1975)

Grignard reaction to prepare tetraphenylcyclopentadienone by ref. to O.S. or Fieser, then 1,2,3,4,5-pentaphenyl-2,4-cyclopentadien-1-ol by reaction w. phenylmagnesium bromide. Sodium amide in isopentyl ether at 173 deg. gives one of two isomeric pentaphenylcyclopentenones. 2-3 hr. lab periods. HAZARDS: Sodium amide is very reactive; ethers form explosive peroxides.

*ORG FRIEDEL.CRAFTS PHOTO PREP SEQ 3 HAZARD

Migratory Aptitudes: An organic chemistry experiment

Zaczek, N. M.; Ruff, J. C.; Jackewitz, A. H.; Roswell, D. F.

J. Chem. Educ. 48,257 (1971)

Prep. methyl- and chloro- benzophenones by Friedel-Crafts, photochem synthesis of benzopinacols. Rearrangement products are cleaved by pot. t-butoxide to acids, analyzed gc, nmr. Cautions: UV exposure, DMSO may be toxic. HAZARD: benzoyl peroxide is explosion hazard.

*ORG COLUMNC GRIGNARD MASSPEC 4

The Preparation of Naphthalene-Alpha-D

Ziegler, G. R.

J. Chem. Educ. 44,609 (1967)

Grignard reaction of 1-bromonaphthalene is quenched w. D₂O. Product eluted from column (no details) and analyzed by ir and (optional) mass spect.

*ORG PHYS DEMO ISOTOPE KIN 4

Lecture Demonstration of a Kinetic Isotope Effect
Zollinger, H.

J. Chem. Educ. 34, 249 (1957)

Explicit directions. Demonstrates a hydrogen-isotope effect. Coupling of 4-chloroaniline with (a) 1-d-2-naphthol-6,8-disulfonic acid and (b) the normal compound. The strongly colored azo compound of the non-deuterated naphthol appears at a visibly faster rate.

Reader (DT) says this was an excellent demo - he saw Z. do it.

*ORG PREP REDOX SAFETY 3

Oxidation of Cyclohexanol to Cyclohexanone by Sodium Hypochlorite

Zuczek, N. M.; Furth, P. S.

J. Chem. Educ. 58, 824 (1981)

This note gives details on hypochlorite substitution for dichromate.

See Perkins, R.A.; Chau, F., J. Chem. Educ. 59, 981 (1982). See also Perkins, R., J. Chem. Ed., 61, 551 (1984).

*PHYS CATAL KIN PHOTO UVIS 2

A Molecular Reaction Cycle With a Solvatochromic Merocyanine Dye:
An Experiment in Photochemistry, Kinetics, and Catalysis

Abdel-Kader, M. H.; Steiner, U.

J. Chem. Educ. 60, 160 (1983)

Merocyanine dye (M) of the stilbazolium betaine type is used in the study of the photoreaction cycle, kinetics of the thermal cis-trans isomerization, and the base-catalyzed thermal isomerization of MH+(cis) to MH+(trans). Eyring reaction rate equation is applied. A molecular light-driven proton pump is shown.

*PHYS ORG ACBA DISTRIB KEQ PHASE 3 HAZARD

An Experiment in Coupled Equilibria

Adamson, R.; Parks, P. C.

J. Chem. Educ. 48, 120 (1971)

Dinitrophenol (DNP) - carbon tetrachloride - water system is characterized by 2 equilibria (1) ionization of DNP in water, and (2) distribution of DNP between CCl₄ and water. Analysis for DNP spectrophotometric at 400 nm. Distb. coefficient and pK_a; all calcs given. HAZARD: CCl₄ is a carcinogen - possibly substitute dichloromethane.

*PHYS CRYSTAL MICROSCOPE SOLID 3

A Solid-State Chemistry Experiment: Dislocations in Etched Calcite by Polaroid Photomicrography

Agnew, N. H.

J. Chem. Educ. 49, 739 (1972)

Requires Polaroid-Land camera, stereomicroscope. Etched pits or cleavage faces show dislocations and orientation.

*PHYS SURFACE 4

Interfacial Spreading: A physical chemistry experiment

Ahmad, J.

J. Chem. Educ. 52, 534 (1975)

The rate of spreading of oleic acid on a thin layer of glycerol can be measured using very simple equipment and related to surface tension. Surface tension measured independently.

*PHYS ORG CYCLOADDITION DIELS-ALDER KIN UVIS 3 4 HAZARD

A Pseudo First-Order-Second-Order Kinetics Experiment: An Illustration of The Guggenheim Method

Ahmad, M.; Hamer, J.

J. Chem. Educ. 41, 249 (1964)

Diels-Alder reaction: p-bromonitrosobenzene and 2,3-dimethyl-1,3-butadiene in CH₂Cl₂ followed by visible spectrometer. Kinetics analyzed by Guggenheim method. HAZARD: nitroso compound may be a carcinogen.

***PHYS NMR PHASE 3 HAZARD**

Using NMR to Determine The Boiling Point Diagram For a Non-Ideal Solution
Allen, F. S.; Coleman, W. F.; Morrow, C. J.; Niemczyk, T. M.
J. Chem. Educ. 52,132 (1975)
NMR used to determine compositions of condensates. A special boiling flask admits small amount of condensate directly to NMR tube. HAZARD: CHCl_3 is a carcinogen.

***PHYS COLOR DEMO OPTICAL QUANTUM UVIS 2**

A Simple System for Demonstration in Spectroscopy
Alman, D. H.; Billmeyer, F. W.
J. Chem. Educ. 53,166 (1976)
Uses overhead projector, slit, and four layers of diffraction grating in a lantern slide mount, to demonstrate continuous spectra, Planck's radiation law, absorption spectra, fluorescence excitation spectra, reflection spectra, subtractive color mixing, and scattering. A tested demonstration.

***PHYS INORG CLOCK DEMO KIN 2**

The Old Nassau Reaction
Alyea, H. N.
J. Chem. Educ. 54,167 (1977)
Explicit directions for this clock reaction (also called the Halloween Reaction), plus teaching suggestions. Common lab reagents. A tested demonstration.

***PHYS ASSOC ELECTROCHEM IONSELECT 4**

Comparing Simple Electrolytes and Polyelectrolytes by the EMF Method:
A physical chemistry experiment
Ander, P.; Casiero, M.; Rocco, M.
J. Chem. Educ. 57,902 (1980)
Illustrates interactions of simple ions with polyelectrolytes. Ion specific electrodes measure mean activity coefficient of NaBr as function of polyelectrolyte type and conc. Theory summarized. Polyelectrolytes: sodium polyphosphate, polydimethylaminobutylene bromide (synthesis given).

***PHYS KIN PHOTO UVIS 3 4**

Photohydration of Pyridine in Aqueous Solution: An undergraduate experiment in photochemical kinetics
Andre, J. C.; Niclaude, M.; Jousot-Dubien, J.; DeGlise, X.
J. Chem. Educ. 54,387 (1977)
Low pressure Hg lamp, quartz cylinder. Absorption max. of pyridine and photoproduct differ, measurements with screens gives rate laws, quantum yields. Seems a very good photochem experiment.

***PHYS APPARATUS LUMIN NOPROC QUANTUM 4**

Triboluminescence Spectroscopy of Common Candies
Angelos, R.; Zink, J. I.; Hardy, G. E.
J. Chem. Educ. 56,413 (1979)
An exercise to introduce student to spectroscopic aspects of triboluminescence. Spectra compared with the photoluminescence spectra. Block diagram of a triboluminescence spectrometer given.

***PHYS BIOCHEM RADIOCHEM THERMO 3 4**

A New Application for Radioimmunoassay
Angstadt, C. N.; Barbieri, E. J.; Chase, G. D.
J. Chem. Educ. 60,513 (1983)
A single lab period expt. that measures iodine-digoxin equilib. binding constant at several temperatures and permits calc. of entropy, enthalpy, and Gibbs free energy. Digoxin I-125 Radioimmunoassay kits (commercially available) and a scintillation spectrometer are required.

***PHYS IONSELECT 3**

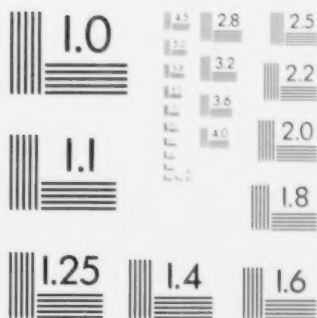
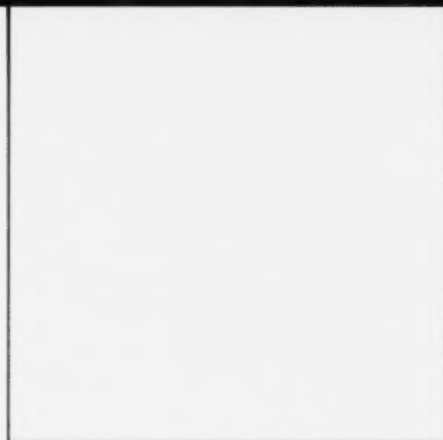
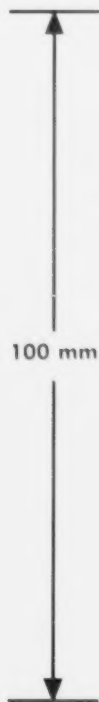
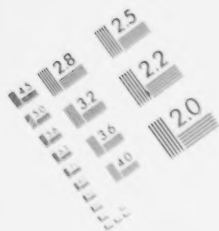
Determination of Activity Coefficients with the Glass Electrode
Annino, R.
J. Chem. Educ. 39,240 (1962)
Not a student experiment, though possibly adaptable. Dil HCl media.

***PHYS INORG APPARATUS COORD MOSSBAUER PROJ QUANTUM SOLID 4**

A Physical Chemistry Experiment in Mossbauer Spectroscopy
Armstrong, W. H.; Dorflinger, E. E.; Anderson, O. T.
Willeford, Jr., B. R.
J. Chem. Educ. 58,515 (1981)
Isomer shifts and quadrupole splittings measured in a series of Fe(III) and Fe(II) complexes. Results interpreted in terms of high/low spin and coordination symmetry. Partly student constructed apparatus described.

***PHYS APPARATUS GC PHASE 5 HAZARD**

Determining Activity Coefficients of Liquid in Binary Solutions : A new method
Amikar, H. J.; Rao, T. S.; Bodhe, A. A.
J. Chem. Educ. 47,826 (1970)
Research report. Quantitative glc using gas sampling, with carrier gas saturated with vapor of sample. Data for 6 binary organic liquids, all of which contain at least one suspected carcinogen. Modified gas chromatograph. See also Barrett, R.; Stewart, T., J. CHEM. EDUC., 49, 492 (1972).



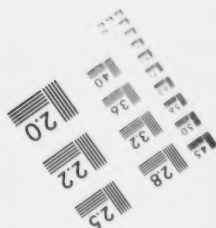
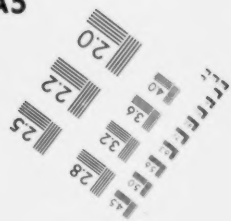
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***PHYS APPARATUS QUANTUM UVIS 4**

The Absorption Spectrum of Sodium Vapor

Ashby, R. A.; Gotthard, H. W.

J. Chem. Educ. 51,408 (1974)

Developed for a first course in spectroscopy. Diagram for absorption cell given. Student is to construct atomic energy level diagram for sodium. Molecular absorption can be measured also.

***PHYS CATAL DEMO EXPLOSION KIN REDOX 4**

Visual Demonstration of the Catalytic Action of Copper on Methyl Alcohol
Ashmore, R. E.

J. Chem. Educ. 45,243 (1968)

An apparatus is described for demonstrating the catalytic effect of CuO on the air-oxidation of methanol. It is said to be safe.

HAZARD: it has been known to explode.

***PHYS ORG GC SEPARATION 3 HAZARD**

Fractionating Column Efficiency: Quantitative experiment in elementary organic laboratory

Ault, A.

J. Chem. Educ. 41,432 (1964)

Benzene-toluene slow distillation thru column, sample pot and distillate, gc. HAZARD: benzene (carcinogen), substitute.

***PHYS APPARATUS PHOTO REDOX UVIS 4 HAZARD**

The Photochemical Oxidation of Aqueous Iodide Solutions: An Experiment Demonstrating The Competitive Reactions of The Hydrated Electron

Ayscough, P. B.; Burchill, C. E.; Ivan, K. J.

J. Chem. Educ. 44,349 (1967)

Special reaction vessel. Dilute HClO₄. Photochemical yield is followed spectrophotometrically. Vary hydrogen ion, nitrous acid conc. Theory (advanced) discussed. Designed for students in Honors course, final year.

HAZARD: HClO₄, storage hazard.

***PHYS APPARATUS ELECTROCHEM TRANSPORT 3 HAZARD**

A Modified Moving Boundary Method For Demonstrating Transference Numbers
Baca, G.; Hill, R. D.

J. Chem. Educ. 47,235 (1970)

Modified Hittorf method, measures resistance of moving boundary, eliminates indicator error; specially designed cell with constrictions. Here cadmium amalgam is used, made from cadmium shavings. HAZARD: carcinogenic and toxic.

***PHYS APPARATUS ELECTROCHEM 2**

Electrochemistry in a Nutshell

Baca, G.; Lewis, D. A.

J. Chem. Educ. 55,804 (1978)

9-chamber plexiglas unit gives better results than usual wet-filter paper for rapid measurement of potential of an assortment of cells. Establish electromotive series.

***PHYS ACBA COMPUTER KEQ PH 3**

The pK_a of a Weak Acid as a Function of Temperature and Ionic Strength: An Experiment Using a pH Meter

Bada, J. L.

J. Chem. Educ. 46,689 (1969)

Expanded scale pH meter. May do least squares fit by computer. Constant temperature bath. Straightforward.

***PHYS COMPUTER IR MOL.SPECT 3**

A Computerized Physical Chemistry Experiment

Bader, M.

J. Chem. Educ. 46,206 (1969)

H or D chlorides, bromides, iodides as gas. Spectral data input to a computer program (available).

***PHYS APPARATUS CALORIMETRY THERMO 3**

Use of a Microcalorimeter for Determining Reaction Enthalpies in Solution

Baffier, N.; Letellier, P.; Labbe, J. P.

J. Chem. Educ. 53,597 (1976)

Modification of an inexpensive differential microcalorimeter to allow reagent injection by microburet described. Student results on neutralization and mixing enthalpies given.

***PHYS KIN TITN 3 HAZARD**

Experiment Demonstrating First Order Kinetics

Baginski, E.; Zak, B.

J. Chem. Educ. 39,635 (1962)

Iodide-catalyzed reaction of ceric with arsenite, kinetics followed by quenching reaction with Hg(II) nitrate. Unreacted ceric titrated with ferrous to orthophenanthroline. Qual. version gives color changes.

HAZARD: CHCl₃.

*PHYS AA-FP APPARATUS MOLSPECT 4

A Novel Method for Measuring Molecular Emission Spectra
Baize, A. I.

J. Chem. Educ. 53,58 (1976)

A new method for measuring molecular emission spectra by easy temporary modification of a atomic absorption spectrophotometer has been developed and applied to record the spectrum of the (C2) molecule (Swan bands).

*PHYS INORG CONSUMERPROD KIN PHOTO REDOX UVIS 2 HAZARD

Photochemical Reactions of Tris(oxalato)Iron(III): A first-year chemistry experiment

Baker, A. D.; Casadavall, A.; Gafney, H. D.; Gellender, M.

J. Chem. Educ. 57,314 (1980)

Rate of photo reduction of Fe(III) to Fe(II), followed by adding ferricyanide ion to form blue ferro ferricyanide complex; analyze 700 nm. Elementary photochemical rate law. Intensity and wavelength dependencies examined. Application to blueprints discussed. Caution: 300W floodlamps, burns. HAZARD: ferricyanide, poison. Ambitious.

*PHYS CLOCK FREERAD KIN 3

A Clock Reaction with Paraquat

Baker, A. D.; Casadavall, A.

J. Chem. Educ. 57,515 (1980)

Paraquat reduced by hydroxide ion to a colored ion radical that is rapidly oxidized by O₂ back to paraquat. Clock reaction based on this, as well as a kinetic study in which a number of variables may be altered. Paraquat hazard is adequately discussed.

*PHYS ANAL ORG KEQ PH 4

Determination of the Ionization Constant of Sparingly Soluble Weak Acids: An Experiment for Analytical Organic Courses

Baldwin, C. E.; Evans, J. S.

J. Chem. Educ. 51,205 (1974)

Potentiometric titration after solubility equilibration gives K_a if K_{sp} is known. Data given for p-methoxy- and p-nitrobenzoic acids. Const. temp. Estd. time, 1 week.

*PHYS CALORIMETRY THERMO 2

Heat of Combustion of Zirconium : A General Chemistry Experiment

Banks, R. C.; Carter, L.; Peterson, E. R.

J. Chem. Educ. 52,235 (1975)

Heat released in firing a flashbulb measured in coffee cup calorimeter. Within capacity of many high school students.

*PHYS ORG ELECTROANAL KIN PROJ 3

The Menshutkin Reaction: A group experiment in a kinetic study

Barnard, P. W. C.; Smith, B. V.

J. Chem. Educ. 58,282 (1981)

A study of kinetics of reaction between pyridine and phenacyl bromide (lachrymator), using change in conductance to follow kinetics. Cell described. Uses Guggenheim method of data analysis. Many variants suggested and typical data given.

*PHYS DEMO KSP SOLUB 2 HAZARD

The Solubility Product of Cadmium Hydroxide

Barrett, R. L.

J. Chem. Educ. 36, A50 (1959)

A Chem-Ed Tested Demo. NaOH sol'n added to Cd++ solution until ppt just appears (strong illumination). OH- concentration in supernatant is est'd from its color with phenol red. HAZARD: avoid Cd++-toxic. Technique should work with other cations.

*PHYS GC PHASE THERMO 3

Gas Chromatography and Thermodynamics

Barrett, R.; Stewart, T.

J. Chem. Educ. 49,492 (1972)

Activity coefficients in mixtures of volatile liquids (acetone-chloroform, benzene-toluene) by gc. CAUTION: benzene and chloroform are carcinogens, but could be handled safely with precautions in this experiment.

*PHYS ASSOC ERROR GAS KEQ VACTEK 3

The Dissociation of Acetic Acid Dimer in the Gas Phase

Barton, D.; Ralph, R.; Kane, K.

J. Chem. Educ. 45,440 (1968)

Standard experiment to measure P vs. T.

*PHYS APPARATUS GAS KIN SOLUB 1 2

A Study of the Physical and Chemical Rates of CaCO₃ Dissolution in HCl

Bassow, H.; Hamilton, D.; Schneeberg, B.; Stad, B.

J. Chem. Educ. 48,327 (1971)

Reaction is followed by collecting CO₂ in a gas buret. Simple apparatus. This experiment was designed for advanced high school students.

***PHYS DEMO KSP QUAL 2**

Simultaneous Equilibria Involving Insoluble Salts

Bauman, J. B.

J. Chem. Educ. 54, 618 (1977)

Red silver chromate (freshly precipitated) is readily converted to white silver chloride by letting it stand in contact with 0.1M NaCl. Supernatant visibly turns yellow as reaction proceeds.

***PHYS ORG APPARATUS INTEGR KIN NOPROC PHOTO VACTEK 4 HAZARD**

Photochemical Kinetics: An integrated laboratory experience

Bazley, M. R. F.; Woolley, G. R.

J. Chem. Educ. 54, 771 (1977)

Photobromination of cinnamic acid can give simple rate equation and quantum yield. Students can prepare and recrystallize cinnamic acid.

Extensions to effect of inhibitors and analysis of product and its stereochemistry. Requires photolysis cell, phototube, amplifier.

HAZARD: carbon tetrachloride (solvent) is carcinogen. For instructors.

***PHYS ELECTROCHEM THERMO 2**

A General Chemistry Thermodynamics Experiment

Beaulieu, L. P., Cpt.

J. Chem. Educ. 55, 53 (1978)

Temp. coefficient of cell potential for Pb-Pb(II), Cu-Cu(II) battery used to measure entropy change. Thus enthalpy change is determined.

***PHYS ANAL DRYLAB NMR 4**

Analysis of Complex NMR Spectra: A Dry-lab Spectral Analysis Experiment

Bell, H. M.

J. Chem. Educ. 54, 180 (1977)

Analysis of non-first order spectra, specifically those of dimethoxyphenol; 1,2,3-tribromo-2-methylpropane; and 1,1,1-trichloro-3-bromo-3-phenylpropane in DMSO-d₆. Study questions. 7 refs on spectral analysis.

***PHYS ORG COMPUTER KIN NMR 4**

NMR Spectral Analysis: An experiment involving complete lineshape analysis of a two-site exchange problem

Bell, H. M.

J. Chem. Educ. 53, 665 (1976)

Temperature-dependent studies (0-100 deg. C) of NMR spectrum of N,N-dimethylacetamide yields rate constants for group rotation, activation energy (Arrhenius plot). Mean lifetimes are found using a computer least-squares curve-fitting program.

***PHYS KIN NOPROC PHOTOCHEM 3 4**

Photosensitized Oxidation by Singlet Oxygen: An adaptable photochemical system

Bell, J. A.; MacGillivray, J. D.

J. Chem. Educ. 51, 677 (1974)

Basic reaction, oxidation of 1,3-diphenylisobenzofuran by singlet oxygen in methanol, methylene blue sensitizer is described. Many possible experiments of varying sophistication can be devised by instructor. Rate measured colorimetrically (420 nm).

***PHYS ORG COMPUTER DRYLAB NMR PHASE 2 HAZARD**

The Acetone-Chloroform System: An NMR Study

Bell, J. A.; Snider, W. H.

J. Chem. Educ. 44, 200 (1967)

NMR spectra given; can be interpreted as hydrogen bond equilibrium. For accelerated Gen. Chem. Could be done as "hands on" experiment.

Hazard: chloroform is now known to be a carcinogen.

***PHYS APPARATUS GAS THERMO UVIS 4**

Spectroscopic Determination of Thermodynamic Quantities

Berger, M.; Bell, J. A.; Steel, C.

J. Chem. Educ. 52, 191 (1975)

Heats of vaporization, sublimation, fusion determined by absorption of vapor in equilibrium with liquid. Data for naphthalene, azobenzene, benzophenone. Diagram of heated cell given.

***PHYS COLOR FLUOR 3 HAZARD**

Long-Range (Forster) Electronic Energy Transfer

A Laboratory Experiment

Berkovic, G.

J. Chem. Educ. 61, 832 (1984)

Steady state fluorescence of pyrene (donor) in the presence of acridine orange (acceptor) is investigated. The mechanism favors the Forster-type non-radiative energy transfer. Fluorescence spectrometer with monochromatic excitation required. CAUTION: pyrene is a possible carcinogen.

***PHYS ANAL ORG CATAL KIN UVIS 3**

Measurement of Acidic Catalysis: A Physical-Organic Laboratory Experiment

Berndt, D. C.

J. Chem. Educ. 48, 200 (1971)

Klett-Summerson or other visible colorimeter; constant temperature bath. Hydrolysis of benzohydroxamic acid in presence of HCl followed by removing samples from a batch, quenching and color-development by iron(III) chloride.

***PHYS CALORIMETRY KIN 2**

Coffee Cup Kinetics

Birk, J. P.

J. Chem. Educ. 53,195 (1976)

Rate constants determined for cooling of hot water in various lab vessels.

Nice "change-of-pace" experiment.

***PHYS CLOCK KIN 2**

A "Clock Reaction" For a Beginning Course in College Chemistry

Black, A. H.; Dodson, V. H.

J. Chem. Educ. 33,562 (1956)

Oxidation of oxalate by ceric is followed visually. Simple level; no kinetic analysis.

***PHYS ORG GLOVER KIN QUANTUM UVIS 4**

Carbonium Ions of Conjugated Molecules: A physical organic experiment

Blatz, P.; Pippert, D.; Sherman, L.; Balasubramanian, V.

J. Chem. Educ. 46,512 (1969)

Cation from trans-retinyl acetate in 2-propanol-sulfuric acid, spectrum 400-260 nm measured quickly, then after fixed times. Requires dark, cold (-30 C), inert atmosphere, careful technique. Quantum calculations of energy and wavelength on free electron model.

***PHYS IR ISOTOPE VACTEK 3**

Infrared Spectrum of Methanol: A First-Year Student Experiment

Boehm, G.; Dwyer, M.

J. Chem. Educ. 58,809 (1981)

Students use table of group frequencies to assign bands in vapor phase spectra of methanol, d1- and d4-methanol. Construction of simple vac line and low pressure IR gas cell described.

***PHYS CRYSTAL XRAY 3**

X-Ray Crystallography "Experiment": Powder Patterns For Alkali Halides

Boer, P. F.; Jordan, T. H.

J. Chem. Educ. 42,76 (1965)

NaCl, LiCl, NaBr, NaI, KCl, KBr, KI, CsCl, CsBr, CsI. Densitometer traces given for recognition. No theoretical analysis.

***PHYS APPARATUS DIPOLE 3**

A Novel Approach For Dipole Moment Laboratory Experiments: A physical chemistry laboratory experiment

Bonilla, A.; Vassos, B.

J. Chem. Educ. 54,130 (1977)

Construction of simple inexpensive app. Results appear precise. Data for chlorobenzene, o-dichlorobenzene.

***PHYS ACBA IONX KEQ 2**

Determining Ionization Constants From Ion Exchange Equilibrium Measurements

Bonner, O. D.; Jackson, R.; Rogers, O. C.

J. Chem. Educ. 39,37 (1962)

Uses acid ion exchange resin. Results depend on ionic strength (Debye-Huckel) for chloroacetic acids.

***PHYS IR MOL.SPECT QUANTUM 4**

C-H Bond Strengths

Boobyer, G. J.; Cox, A. P.

J. Chem. Educ. 45,18 (1968)

C-H and C-D fundamental and overtone bands for chloroform, bromoform, 1,1,2-trichloroethene, and 3-bromopropyne measured. Morse and Lippincott-Schroeder functions and dissociation energies calculated.

***PHYS KIN MEMBRANE OSMOSIS 3**

An Experiment on Osmotic Flow

Borero, L. M.

J. Chem. Educ. 36,244 (1959)

A semipermeable membrane of cupric ferrocyanide is formed in the shape of a drop by the reaction of a cupric sulfate solution containing albumin and sucrose/glucose to a solution of potassium ferrocyanide. As water diffuses into the drop, K₂SO₄ is formed which eventually causes the visual coagulation of the albumin, allowing the rate of osmosis to be studied.

***PHYS APPARATUS GAS VAPORPRESS 3**

Capillary Method For Measuring Saturated Vapor Pressures

Borrell, P.; Nyburg, S. C.

J. Chem. Educ. 42,551 (1965)

Capillary with mercury pellet trapping liquid and air mounted in a heating tube with stirrer and thermometer. Method can be used for experiments in Raoult's law derivations (suggested only). Not a student experiment but could be useful.

***PHYS INORG DEMO KIN OSC.RXN 2**

The Color Blind Traffic Light

Boulanger, M. M.

J. Chem. Educ. 55, 584 (1978)

Useful modifications to decrease induction period, Lefelhocz, J.F., J. CHEM. EDUC., 49, 312 (1972).

***PHYS POLYMER DEMO PHOSPHOR UVIS 2**

Phosphorescence: A Demonstration

Bramwell, F. B.; Spinner, M. L.

J. Chem. Educ. 54, 167 (1977)

Directions for making demonstration samples of phosphorescent materials (triphenylene, phenanthrene, naphthalene, biphenyl) activated by uv, in a polymer matrix (methyl methacrylate), for use at room temperature. A tested demonstration.

***PHYS DIPOLE GEOM NOPROC THERMO 3**

Dipole Moments of 1,2-Disubstituted Ethanes and their Homologs: An experiment for physical chemistry

Braun, C. L.; Stockmayer, W. H.; Orwoll, R. A.

J. Chem. Educ. 47, 287 (1970)

Conformations of disubstituted ethanes and rotational barriers from dipole moment measurements.

***PHYS GAS 1**

An Experimental Approach to the Ideal Gas Law

Breck, W. G.; Holmes, F. W.

J. Chem. Educ. 44, 293 (1967)

Simple apparatus for measuring gas volumes in a closed capillary trapped by mercury. Bath to change temp. Lay flat or invert to get three different pressures.

***PHYS ACBA COMPLEX KEQ UVIS 3**

Lewis Acid Base Equilibria: An undergraduate laboratory experiment

Brice, L. K.

J. Chem. Educ. 50, 430 (1973)

Determination of formation constants of adducts of type $MX_n:B$, where $MX_n = ZnBr_2$ and $B = o-, m-, p-$ -nitroaniline. Spec-20, rotocell.

Note: two absorbing species present. Isobestic point at 375 nm.

***PHYS KIN UVIS 2**

The Rate of Iodination of Aniline: A physical chemistry experiment

Brice, L. K.

J. Chem. Educ. 39, 632 (1962)

Iodine plus I⁻ in H₂O sol'n. Kinetics followed by titration of residual I₂ or spectrophotometrically. Conc. of aniline and pH varied.

***PHYS COORD GEOM KIN PREP UVIS 2**

A First Order Rate of Isomerization: A physical chemistry experiment

Brice, L. K.

J. Chem. Educ. 39, 634 (1962)

Both cis- and trans- bisethylenediaminedichlorocobalt(III) prepared. Cis converts to trans in methanol. Absorption of 540 nm used to get first order plot.

***PHYS IR QUANTUM VACTEK 4**

Vibrational Frequencies of Sulfur Dioxide: Determination and Application

Briggs, A. G.

J. Chem. Educ. 47, 391 (1970)

Double beam ir, gas cell.

***PHYS APPARATUS CRYO PHASE THERMO VAPORPRESS 3**

Determination of the Latent Heats and Triple Point of Perfluorocyclobutane.

The importance of a simple vapor pressure study.

Briggs, A. G.; Strachan, A. N.

J. Chem. Educ. 54, 482 (1977)

Portable glass apparatus (requires vac. technique for one-time filling); perfluorocyclobutane and manometer. Measure pressure at temperatures (5 deg. intervals) to -55 deg. C.

***PHYS CATAL CLOCK DEMO KIN OSC.RXN 2 3**

An Oscillating Iodine Clock

Briggs, T. S.; Rauscher, W. C.

J. Chem. Educ. 50, 486 (1973)

KIO₃, H₂O₂, HClO₄ OR H₂SO₄, malonic acid, MnSO₄. Gives visible fluctuation in iodine concentration (starch). Many variants suggested. See also Deb, B.M., J. CHEM. ED., 54, 236 (1977). But concentrations are not critical for oscillations.

***PHYS CRYSTAL DRYLAB MISTAKE MOL.SPECT 4 5**

Nuclear Quadrupole Resonance of R3SbX2 Compounds

Brill, T. B.

J. Chem. Educ. 58 ,519 (1981)

Students given data and a summary of spectral data, asked a series of questions to interpret data. Hard to understand without structures which were omitted by error and apparently never corrected.

***PHYS CRYSTAL LASER NOPROC XRAY 3**

A Practical Method of Simulating X-Ray Diffraction

Brisse, F.; Sundararajan, P. R.

J. Chem. Educ. 52 ,414 (1975)

Suggestions for student study of diffraction using He-Ne laser and masks to simulate diffraction grating, molecules, two-dimensional arrays.

***PHYS INORG KEQ KIN REDOX TITN UVIS 3**

Static and Kinetic Measurements of an Equilibrium Constant: A physical-inorganic chemistry experiment

Britton, D.; Hugus, Z. Z., Jr.

J. Chem. Educ. 40 ,607 (1963)

Equilibrium constant of arsenic acid-iodide reaction is determined by direct titration and calculated from spectrophotometric data.

***PHYS APPARATUS KIN UVIS VACTEK 3**

The Kinetics of Nitrogen Atom Recombination: An undergraduate physical chemistry experiment

Brown, G. R.; Winkler, C. A.

J. Chem. Educ. 54 ,185 (1977)

N atoms generated in flow system by microwave or by elect. discharge and measured indirectly spectrophotometrically.

***PHYS ANAL ACBA COLOR KEQ UVIS 3**

Acid-Base Indicators: An experiment in aqueous equilibria

Brown, W. E.; Campbell, J. A.

J. Chem. Educ. 45 ,674 (1968)

Absorbances of six acid-base indicators, discussion of purity.

***PHYS INORG COORD MAGNETIC 3**

Magnetic Susceptibility: A physical chemistry laboratory experiment

Brubacher, L. J.; Strafford, F. E.

J. Chem. Educ. 39 ,574 (1962)

Solids measured in Gouy balance, with varying field strength electromagnet. Iron(II) ammonium sulfate hexahydrate standard.

***PHYS COORD KIN UVIS 3**

Correlation Between Ligand Field Theory and Complex Dissociation: A kinetics experiment

Brumfitt, G.

J. Chem. Educ. 46 ,250 (1969)

o-Phenanthroline and 5-nitro-1,10-phenanthroline complexes of divalent Co, Ni, Cu. Kinetics of decomposition by mercuric nitrate. Requires thermostatted cell.

***PHYS KIN REDOX TITN 3**

Activation Energy Determination: An organic chemistry experiment

Bryan, A. M.; Olafsson, P. G.

J. Chem. Educ. 46 ,248 (1969)

Decomp. of N-bromobenzamide in base, followed by thiosulfate titration. Within capacity of many freshmen.

***PHYS ORG ACBA CATAL KIN PROJ UVIS 3 4**

General Acid Catalysis: A Flexible Experiment, Adaptable to Student Ability and Various Teaching Approaches

Bulmer, R. S.; Senogles, E.; Thomas, R. A.

J. Chem. Educ. 58 ,738 (1981)

Investigates kinetics of acid catalysed hydrolysis of N-vinylpyrrolidone. Results discussed in terms of specific vs. general acid catalysis, kinetic isotope effect, ionic strength, and Bronsted Catalysis Law. Conc. of reactant followed spectrophotometrically (233-255 nm). Procedures and data analysis described.

***PHYS ORG KIN UVIS 3**

A Spectrophotometric Kinetic Experiment Illustrating Consecutive Reactions-The Methanolysis of Methyl p-Nitrophenyl Sulfate

Buncel, E.; Raoult, A.; Wiltshire, J. F.

J. Chem. Educ. 51 ,814 (1974)

Requires thermostatted cell, scanning UV spectrophotometer. Preparation of methyl p-nitrophenyl sulfate from Can. J. Chem. ref. Reaction followed by scanning UV spectrum.

***PHYS ELECTROANAL FASTREACTION KIN 3**

Kinetics of Fast Brominations: A Potentiometric Study

Burgess, A. E.; Latham, J. L.

J. Chem. Educ. 46,370 (1969)

Kinetics of bromate/bromide reaction studied by bromination of various phenols in aq. sol'n, reaction followed potentiometrically. Simple apparatus, one lab period.

***PHYS DENSITY SOLID 0 1 2**

The Density of Solids

Burgess, D.

J. Chem. Educ. 61,242 (1984)

A variant on the usual density expt. which uses various irregularly shaped objects which do not fit into a graduated cylinder, and a balance with inadequate weights. Students must decide how to measure volume and mass. Develops problem solving skills and independent thought.

***PHYS COORD DEMO KEQ 2**

Chemical Equilibrium

Burke, B. A.

J. Chem. Educ. 54,29 (1977)

Colorless aq. KBr added to blue aq. CuSO₄ gives green solution of K₂CuBr₄; reversed by excess sulfate ion and by warming. A tested demonstration.

***PHYS CLOCK KIN 2**

The Mechanism of the Formaldehyde Clock Reaction: Methylene Glycol Dehydration

Burnett, M. G.

J. Chem. Educ. 59,160 (1982)

This is not the experiment, but the background for the experiment. Also gives conditions for reliable use of reaction, and typical results. Discussion is excellent.

***PHYS ORG DRYLAB GAS MASSPEC 4 5**

An Interpretive Experiment in Ion Cyclotron Resonance Spectroscopy

Burnier, R. C.; Frieser, B. S.

J. Chem. Educ. 56,687 (1979)

Intended to provide the student with experience in analyzing ICR spectra. Methane (ions) and ions derived from mixtures of methane plus org. bases.

***PHYS KIN LUMIN PHOTO 4**

Uranyl Luminescence Quenching: An experiment in photochemistry and kinetics

Burrows, H.; Formosinho, S. J.

J. Chem. Educ. 55,125 (1978)

Quenching by microliter amounts of alcohols gives information on mechanism. Stern Volmer kinetics.

***PHYS BIOCHEM KEQ NMR TITN 3 4**

NMR Titration of Carnosine as a Model Biochemistry Experiment

Burt, C. T.

J. Chem. Educ. 57,1056(1982)

Proton nmr is used to determine the three ionization constants of beta-alanylhistidine. Procedures by ref. Extensions to metal binding, change of Keq with temperature.

***PHYS INORG ACBA APPARATUS COORD DEMO KEQ 1**

Chemical Equilibrium

Butler, S. B.

J. Chem. Educ. 37, A73 (1960)

A Chem-Ed Tested Demo. A Soxhlet extractor is used a) to demonstrate the change in color of CoCl₂ with hydration, b) Bi³⁺ + +/BiOCl equilibrium with change in acidity. In one case, there is a color change when the Soxhlet extractor empties; in the other there is a change from a turbid to a clear solution.

***PHYS KIN PHOTO REDOX 2**

The Kinetics of Photographic Development: A general chemistry experiment

Byrd, J. E.; Perona, M. J.

J. Chem. Educ. 59,335 (1982)

Two 3-hr lab periods, suitable for large classes. The students study the rate of development of a photographic negative vs. hydroquinone concentration in the developer, and temperature. Requires prepared developer and fixer, dark.

***PHYS ANAL ORG PREP TCHROM THERMO UVIS 3 4**

Thermodynamic Data From The Thermochromic Effect

Byrne, J. P.

J. Chem. Educ. 55,267 (1978)

Preparation of a spiropyran from 1,3,3-trimethyl-2-methylindoline and 2-hydroxy-1-naphthaldehyde (references given). Recording visible spectrophotometer with heated cell (30 to 70 degrees). Beers law plot to get concentrations.

***PHYS COMPUTER DRYLAB KIN 3**

Laboratory-Equivalent Minicomputer Experiments: A kinetic application
Cabrol, D.; Cachet, D.; Basso, J. H.
J. Chem. Educ. 52,266 (1975)
Simulation experiments. Interactive program. Computers-in-chemistry experiment.

***PHYS INORG DEMO REVIEW 2**

Sealed Tube Experiments
Campbell, J. A.
J. Chem. Educ. 47,273 (1970)
A collection of 64 experiments exemplifying practically everything taught in General Chemistry. Not all are sealed tube. Intended for lecture demo., but many are suitable for student exp'ts. But don't let students read; these are not cook-book, but ideas.

***PHYS COURSE KEQ KIN NOPROC PHASE UVIS VACTEK 2 3**

What Goes on in the Laboratory?
Campbell, J. A.
J. Chem. Educ. 42,488 (1965)
Examples of experiments in a three-semester general and physical course at Harvey-Mudd. Emphasis on minimal student direction, problem solving.

***PHYS COMPUTER DISTRIB ERROR TITN 3 HAZARD**

A Distribution Experiment
Campbell, J. A.; Nelson, D.; Rudesill, J.
J. Chem. Educ. 46,454 (1969)
Careful procedures in measuring distribution of aliphatic acids between water and organic solvents includes aq. and non-aq. acid-base titration.
HAZARD: avoid CHCl_3 and benzene, carcinogens.

***PHYS QUANTUM UVIS 4 HAZARD**

The 1A_{lg} to 1B_{2u} Transition of Benzene: A physical chemistry experiment
Campbell, M. K.
J. Chem. Educ. 57,756 (1980)
Group theory used to analyze coupled electronic-vibrational transitions. High resolution (+0.1nm) UV-VIS spectrophotometer required. HAZARD: benzene, carcinogen.

***PHYS PHASE SEPARATION 3 HAZARD**

Fractional Distillation: A laboratory experiment
Campbell, R. D.
J. Chem. Educ. 39,348 (1962)
HETP det'n with different reflux ratios, pressures, columns. HAZARD: benzene and chloroform are carcinogens.

***PHYS ACTIVITY KSP NOPROC 3 HAZARD**

Variation of the Solubility Product Constant with Ionic Strength
Carmody, W. R.
J. Chem. Educ. 36,125 (1959)
Cadmium nitrate - potassium iodate titrations at various concentrations. Concentration solubility product and thermodynamic solubility product determined. HAZARD: cadmium toxicity.

***PHYS DEMO GAS 2**

Balloon Balance Thermometer. A Lecture Demonstration of Charles' Law.
Carney, G. D.; Kern, C. W.
J. Chem. Educ. 56,823 (1979)
The "balloon-balance" thermometer makes use of air as a thermometric fluid, a water bath as a thermometric vessel, and the reading of the triple beam-balance as the thermometer scale. Detailed presentation. Extrapolate to find -273 deg. with 10% accuracy.

***PHYS AVOGADRO HISTORIC 2**

Estimation of Avogadro's Number
Carroll, K. L.; Neilsen, E. K.
J. Chem. Educ. 35,198 (1958)
A tenth of a millimeter of a standard oleic acid/pentane solution is placed on a water surface covered with a film of "oxidized piston oil" and dusted with lycopodium powder. The height of the oleic acid layer = 1 molecular dimension can be estimated from $h \times A(\text{film}) = w/\text{density (oleic acid)}$. This exp't became a standard "first experiment". Complete calculations given.

***PHYS APPARATUS DENSITY KIN MICELLE 3**

Density Measurements With a Magnetically Controlled Float
Cartan, F.; Anacker, E. W.
J. Chem. Educ. 37,36 (1960)
Complete construction details. Used to det'n critical micelle conc., rate constant for acetal hydrolysis, densitometric titrations, and partial molal volumes.

***PHYS GAS 2**

A Simple Gas Law Apparatus

Carter, K. N.

J. Chem. Educ. 39,302 (1962)

Simple method for trapping air in a glass tube and measuring pressure, volume, temperature.

***PHYS CLOCK KIN NAME 2**

Faster Than a Speeding Bullet: A freshman kinetics experiment

Cassen, T.

J. Chem. Educ. 53,197 (1976)

Formaldehyde clock, measuring dependence on conc. A, conc. B, temp.

***PHYS ACBA KEQ TITN 2 3**

An Alternative Method for the Determination of pKa

Castillo, C. S.; Micotta, G. S.; Grajales, M. T.

J. Chem. Educ. 61,1067(1984)

The use of acid-base titration data to find the pKa of a weak acid is described, a simplification of a method widely used in research. The pKa of acetic acid is determined.

***PHYS DEMO LASER MOL.SPECT UVIS 1**

Demonstrations for High School Chemistry: Uses of He-Ne Laser

Castka, J. F.

J. Chem. Educ. 53,573 (1976)

Helium-neon laser does not give surface photoelectric effect with Zn, whereas UV radiation does. Wavelength measured.

***PHYS APPARATUS SOLUB THERMO 3**

Heats of Solution From Solubility Determinations

Cesaro, A.; Russo, E.

J. Chem. Educ. 55,133 (1978)

App. designed to give quick, accurate solubility determinations as a function of temp. Enthalpy from van't Hoff plot.

***PHYS INORG BIOCHEM COLLOID CONSUMERPROD DEMO 1 2**

Illustrating Chemical Concepts Through Food Systems: Introductory

Chemistry Experiments

Chambers, IV, E.; Setser, C. S.

J. Chem. Educ. 57,312 (1980)

Simple exp'ts illustrate gas diffusion, reaction rates, surface adsorption, true solutions, colloid dispersions, suspensions, gels and pH. Qualitative.

***PHYS ANAL ACBA DEMO KEQ PH 2**

A Buffer Solution and Its Action

Chang, J. C.

J. Chem. Educ. 53,228 (1976)

Simple demo of effect of addition of acids, etc., to acetate buffers. Uses a "projection pH meter".

***PHYS APPARATUS KIN TECHNIQUE 3**

Determination of the Arrhenius Activation Energy Using a Temperature-Programmed Flow Reactor

Chan, K. C.; Tse, R. S.

J. Chem. Educ. 61,547 (1984)

Uses a flow reactor, temperature programming, and a thermal conductivity detector. Activation energies are determined for the unimolecular thermal decomposition of a series of cycloalkenes.

***PHYS ORG APPARATUS GAS KIN STOICH 3**

A Stoichiometric Study in The Gas Phase: Bromination of Unsaturated Hydrocarbons

Charlson, A. J.; Shapiro, J. S.; Ware, G. W.; Watton, E. C.

J. Chem. Educ. 55,338 (1978)

Bromine vapor reacted with excess gaseous olefin to yield liquid products. Stoichiometry and kinetics followed by pressure change. Seems awkward, and results in some cases do not correspond with theory.

***PHYS CALORIMETRY CATAL KIN PROJ THERMO UVIS 3**

The Kinetics and Thermodynamics of the Phenol from Cumene Process:

A physical chemistry experiment

Chen, E. C. M.; Sjoberg, S. L.

J. Chem. Educ. 57,458 (1980)

Enthalpy change, activation energy, rates measured for proton catalysed decomposition of cumene hydroperoxide to phenol and acetone in acetone solvent (one part of the title process). Homemade calorimeter. Rate law derived from multistep mechanism. Reaction orders in hydroperoxide, water and (H+) determined from rate data. Long, complex procedure. Caution: acetone, fire hazard.

***PHYS DEMO KIN 2**

A Color Indicating Time Reaction

Chen, P. S.

J. Chem. Educ. 47,A78 (1970)

Reaction of Fe+3 ion w. thiosulfate gives a sequence of colors due to complex formation, then redox.

***PHYS ELECTROANAL KEQ 2**

Potentiometric Measurements of Equilibria in General Chemistry Laboratory
Chesick, J. P.; Patterson, A., Jr.
J. Chem. Educ. 36,496 (1959)
Det'n of Ksp of AgCl, Ka of acetic acid, and Kf of silver-ammonia complex in 1 lab period. Inexpensive potentiometer.

***PHYS APPARATUS ELECTROANAL KIN 3**

Determination of Reaction Rates With an A.C. Conductivity Bridge: A student experiment
Chesick, J. P.; Patterson, A., Jr.
J. Chem. Educ. 37,242 (1960)
Hydrolysis of t-butyl chloride followed using an inexpensive AC conductance bridge (circuit diagram). Guggenheim analysis. Developed for freshman honors.

***PHYS APPARATUS THERMO VACTEK 3**

A Simple Equilibrium Method For Determining Heats of Sublimation
Chickos, J. S.
J. Chem. Educ. 52,134 (1975)
Sample at temp-1 is equilibrated with an evacuated ballast tank maintained at temp-2. After equil., sample compartment is closed off and vapor condensed. Enthalpy from Clapeyron eq'n. Thymol, etc. Not written as a student experiment, but adaptable.

***PHYS GAS 2**

Ideal and Non-Ideal Gases: An experiment with surprise value
Chirpich, T. P.
J. Chem. Educ. 54,378 (1977)
Simple experiment intended to promote abstract thinking, understanding of kinetic molecular theory. Compares pressure change in cooling air (extrapolates Charles' Law) with that in cooling water vapor. No black box.

***PHYS DTA PHASE 2 3**

Phase Diagram of The Lead-Tin System by Differential Thermal Analysis
Chiu, G.
J. Chem. Educ. 55,205 (1978)
Straightforward.

***PHYS DEMO GAS SURFACE 2**

Bubble Pressure And Volume
Christian, S. D.; Enwall, E.
J. Chem. Educ. 55,536 (1978)
Logic experiment interprets pressure change with volume. Black box contains a tube open to soap film.

***PHYS ORG DISTRIB NMR PHASE 4 HAZARD**

A Study by NMR of a Three-Component System: A physical-organic experiment
Claasen, R.; Wolcott, R.; Reirbold, P. E.
J. Chem. Educ. 55,542 (1978)
CHCl₃, acetic acid, water in various proportions are phase equilibrated. Phases separated and nmr (integrated) used to det'n composition. HAZARD: chloroform is a suspected carcinogen.

***PHYS KIN 3 HAZARD**

The Kinetics of The Bromate-Bromide Reaction
Clarke, J. R.
J. Chem. Educ. 47,775 (1970)
Followed by bromination of phenol aliquot in dilute HClO₄ solution. Excess bromine bleaches methyl orange. Two 3-hr lab periods if stock solutions supplied. Rate constants, orders in reactants and activation energy calculated. Author says phenol-HClO₄ mixtures, being dilute, are not hazardous. The bibliographers disagree: they are a serious storage hazard even if they have not yet detonated while in use.

***PHYS PHASE REFRACT 3**

Tie Lines in Phase Diagrams for Ternary Liquid Systems
Clarke, J. R.
J. Chem. Educ. 51,225 (1974)
1,2-Dichloroethane-water-acetic acid system by refractometry. Refractive indices, phase diagram given.

***PHYS INORG NOPROC UVIS 4 5**

The Application of Diffuse Reflectance Spectroscopy to Inorganic Chemistry
Clark, R. J. H.
J. Chem. Educ. 41,488 (1964)
Spectra of solids gives structural information. Differences from solution absorptions show solvent interactions. Requires attachment to a good scanning spectrometer. Not designed as student experiment, but adaptable.

***PHYS ORG ACBA BIOCHEM KEQ UVIS 3**

Determination of the Microscopic Ionization Constants of Cysteine

Clement, G. E.; Hartz, T. P.

J. Chem. Educ. 48 ,395 (1971)

Cysteine is a tri-functional amino acid. Ionization scheme given; seven ionization constants determined by a method combining acid-base titration and UVIS spectroscopy. Recording spectrophotometer preferred. Spec-20 OK. Assorted buffers needed.

***PHYS CALORIMETRY THERMO 2**

Heat of Precipitation

Clever, L. H.

J. Chem. Educ. 38 ,470 (1961)

An Erlenmeyer flask in a 500-ml beaker with wadded up paper towels in the dead space is used as the calorimeter. Heat capacity of the calorimeter is det'd from the heat of neutralization (13.6 kcal/mole H⁺). The heat of pptn of AgCl (and/or AgBr) is then det'd by mixing the reagents. Reader (DT) and bibliographers suggest use Ba⁺⁺/SO₄⁼ pptn - less expensive.

***PHYS APPARATUS DIFFUSION 3 4 HAZARD**

A Practical and Convenient Diffusion Apparatus: An undergraduate physical chemistry experiment

Clifford, B.; Ochial, E. I.

J. Chem. Educ. 57 ,678 (1980)

Special apparatus (illustrated) constructed from teflon stopcock for measuring diffusion coefficients in aqueous sol'n by "free boundary method". Solutes: sucrose, potassium dichromate. HAZARD: chromium compounds, potential carcinogens.

***PHYS APPARATUS DEMO DENSITY 3**

A Demonstration Experiment on Partial Molar Volumes

Coch, J. A.; Lopes, V.

J. Chem. Educ. 47 ,270 (1970)

Specially designed volumetric flask used to find partial molar volume of trichloroacetic acid, aq. sol'n.

***PHYS DIPOLE GAS REFRACT VACTEK 4**

Gas Phase Dipole Moment and Refractive Index Determinations: Two physical chemistry experiments

Coe, D. A.; Nibler, J. W.

J. Chem. Educ. 50 ,82 (1973)

Dipole moment by oscillator and freq. counter only. Refractive index using interferometer (construction details, or purchased). HCl, COS, CF₄, etc.

***PHYS APPARATUS INSTR PROJ REFRACT 3**

Construction of a Simple Refractometer: A chemical instrumentation experiment

Coe, G. R.; Conlon, R. D.; Dessy, R. E.

J. Chem. Educ. 41 ,337 (1964)

Requires photocell, Wheatstone bridge. Resistance vs. refractive index of standards used to prepare calibration curve. Some glassblowing.

***PHYS COLOR DENSITY 2**

A First General Chemistry Laboratory Experiment

Cohen, S. H.; Zabel, D. E.; Shores, R. D.

J. Chem. Educ. 47 ,66 (1970)

Note describes an experiment on subjective (color, odor) vs. objective (density) properties. Caution: the description is somewhat sexist. (I think most women would resent the remarks made. CBA)

***PHYS DISTRIB PHASE TECHNIQUE 3**

A Simple Method for Deriving a Boiling Point-Composition Diagram for a Binary Mixture

Coleman, H. M.

J. Chem. Educ. 49 ,471 (1972)

Toluene/acetone by distillation. Essentially identical to 1967 article.

***PHYS DISTRIB PHASE TECHNIQUE 3**

Laboratory Demonstration of Fractional Distillation

Coleman, H. M.

J. Chem. Educ. 44 ,476 (1967)

Addition of 10 percent aqueous salt solution to acetone-toluene distillate mixture separates the components, permits distillate analysis. See also Coleman, H.M., J. CHEM. EDUC., 49, 471 (1972).

***PHYS DIPOLE GAS VACTEK 4**

An Experiment on Dipole Moments and Polarizabilities of Gas Molecules

Cole, R. H.; Berberian, J. G.

J. Chem. Educ. 48 ,129 (1971)

Wayne-Kerr bridge and capacitance cells, gas-handling system, SF₆, CHF₃. Detailed calculations.

***PHYS APPARATUS PHASE VAPORPRESS 3**

Method for the Determination of Liquid-Vapor Binary Equilibria
Colgate, S. O.; Hanrahan, R. J.
J. Chem. Educ. 41,433 (1964)
Apparatus for sampling, easily constructed.

***PHYS ELECTROCHEM 4**

The Measurement of the Conductance of Electrolyte Solutions
A dc method.
Colton, R.; Sketchley, G. J.; Ritchie, I. M.
J. Chem. Educ. 53,130 (1976)
A straightforward method for measuring the absolute value of the conductance of an electrolyte solution. Based on a method described but not heretofore used in a teaching experiment. Conductance cell requires glassblowing.

***PHYS QUANTUM UVIS 2**

The Spectrum of Atomic Hydrogen: A mass scale freshman laboratory experiment
Companion, A.; Schug, K.
J. Chem. Educ. 43,591 (1966)
Inexpensive student-built spectroscope (J. Chem. Educ. 39, 47(1962)) to measure H-spectrum, deduce Rydberg constant.

***PHYS DEMO DENSITY DIFFUSION LIQUID 2**

Diffusion of Potassium Permanganate as a Lecture Demonstration
Conard, C. R.; Bent, H. E.
J. Chem. Educ. 46,758 (1969)
Short note describes use of a density gradient column to avoid convection currents in classical demo of ionic diffusion.

***PHYS ANAL CATAL KIN 2**

A Simple Kinetics Experiment: For General Chemistry Laboratory
Cone, W. H.; Hermens, R. H.
J. Chem. Educ. 40,421 (1963)
Silver ion catalyzed reaction of benzoic acid with $\text{S}_2\text{O}_8^{2-}$ ion, iodometric.

***PHYS APPARATUS KIN TECHNIQUE VACTEK 5**

A Molecular Beam Apparatus for Student Experiments on Reactive Scattering
Conley, R. J.; Greene, E. F.; McInnis, S. M.
J. Chem. Educ. 51,620 (1974)
Specially built molecular beam measures scattered reactants and products. Interpretation is sophisticated. Potassium metal plus a collision beam of bromine or iodomethane as partner.

***PHYS DENSITY NOPROC REFRACT SURFACE VISC 3 HAZARD**

The Measurements of Properties in Physical Chemistry
Coolidge, E. C.
J. Chem. Educ. 37,141 (1960)
Pedagogical. Student issued 1 unknown for determination of approx. 10 phys. properties and identification. List of possible unknowns given.
Hazard (avoidable): benzene.

***PHYS INORG ACBA COORD KIN UVIS 3 4**

The Protolysis of $(\text{Coen}_2(\text{O}_2\text{CO}))^+$: A realistic undergraduate kinetics experiment
Cooper, J. N.
J. Chem. Educ. 57,823 (1980)
Bisethylenediaminecarbonatocobalt(III) chloride synthesized. Rate of protolysis measured photometrically in chloroacetate buffers as function of pH and carbonate complex conc. Dependence of pseudo-first order rate constant on (H^+) conc. determined.

***PHYS KIN UVIS 3**

A Colorimetric Chemical Kinetics Experiment
Corsaro, G.
J. Chem. Educ. 41,48 (1964)
Reaction of crystal violet and NaOH followed spectrophotometrically. Ionic strength is a variable. Within capacity of many freshmen.

***PHYS ASSOC EDTA KSP SOLUB TITN 3**

Ion Strength, Ion Association, and Solubility
Corsaro, G.
J. Chem. Educ. 39,622 (1962)
Sat'd CaSO_4 in solutions of varying ionic strength. Solubility analyzed by EDTA titration for Ca ion, some theory and illustrative calculations. Caution: ammonium perchlorate is a storage hazard.

***PHYS ASSOC CATAL ELECTROANAL KIN MICELLE 3 4**

Micelle Catalysis of an Ionic Substitution Reaction

Corsaro, G.

J. Chem. Educ. 57,225 (1980)

Titration with I₂ used to determine rates of rxn. of thiosulfate with bromoacetate in presence of cetyltrimethylammonium bromide and cations Na⁺, Ca⁺⁺, La⁺⁺⁺. Object is to investigate effects of electrostatic cation/anion association on transition state complex, and enthalpy and entropy of activation. CAUTION: bromoacetic acid is a lachrymator.

***PHYS ORG CATAL KIN MICELLE UVIS 3**

Micelle Catalysis of an Aromatic Substitution Reaction

Corsaro, G.; Smith, J. K.

J. Chem. Educ. 53,589 (1976)

Iodination of aniline is catalyzed in sodium lauryl sulfate solution; this compound forms micelles with negatively charged pseudo surfaces. Iodine measured colorimetrically.

***PHYS ASSOC CATAL COMPUTER KIN REDOX 4**

Ion Association and Ionic Reaction Rates: An Investigation of The Bromoacetate-Thiosulfate Reaction

Cosgrove, R. K.; King, P. W.; Norris, A. C.

J. Chem. Educ. 48,626 (1971)

Measuring rate dependence on salt effect, third ion catalysis. Iodimetry. Sophisticated analysis.

***PHYS ANAL IONSELECT KEQ PH 3**

Acid Dissociation Constant of the Ammonium Ion Using the Glass Electrode

An Undergraduate Experiment

Covington, A. K.; Caudle, J.

J. Chem. Educ. 49,552 (1972)

Glass/ ammonium chloride, ammonia, MCl / AgCl / Ag, where MCl is a soluble chloride. pH meter.

***PHYS ANAL IONSELECT KEQ THERMO 3 4 HAZARD**

The Dissociation Constant of HF: An Undergraduate Experiment with the Lanthanum Fluoride Ion-Selective Electrode

Covington, A. K.; Thain, J. M.

J. Chem. Educ. 49,554 (1972)

Polyethylene working equipment. LaF₃ electrodes from Corning.

HAZARDS: Fluorides are highly toxic and NaF/HCl mixtures are corrosive.

***PHYS COMPUTER TECHNIQUE THERMO 4**

Flame Temperature: A physical chemistry experiment

Craig, N. C.; Carlton, T. S.; Schoonmaker, R. C.

J. Chem. Educ. 51,54 (1974)

Measurement of methane-air flames by means of the sodium D-line reversal technique. L&N pyrometer. Local computer program for thermodynamic functions.

***PHYS ELECTROANAL KIN NOPROC 4**

Kinetics from Polarography: An experiment for the teaching laboratory

Crooks, J. E.; Bulmer, R. S.

J. Chem. Educ. 45,725 (1968)

The height of a polarographic wave may be determined by the rate of a reaction. Rx studied is formaldehyde hydrate (irreducible) to formaldehyde (reducible) in aq. phosphate buffered solution. Much theoretical discussion; little experimental detail.

***PHYS APPARATUS ELECTROCHEM KIN NOPROC 2**

A Stabilized Linear Direct Reading Conductance Apparatus: The solvolysis of t-butyl chloride

Cyr, T.; Prudhomme, J.; Zador, M.

J. Chem. Educ. 50,572 (1973)

Construction of sturdy lower-cost conductance equipment given. Expt. designed for first-year students. Worksheet given.

***PHYS IR QUANTUM 4**

Potential Curves For The I₂ Molecule: An undergraduate physical chemistry experiment

D'Alterio, R.; Mattson, R.; Harris, R.

J. Chem. Educ. 51,282 (1974)

Straightforward.

***PHYS APPARATUS NOPROC VAPORPRESS 3**

Isopiestic Vapor Pressure Apparatus: A physical chemistry experiment

Dailey, G. W.; Huff, R. B.; Kang, J.; Queen, L. D.; Patterson, C. S.

J. Chem. Educ. 38,28 (1961)

Describes method and apparatus only. Glass vacuum desiccator, polystyrene float, silver dishes, etc.

***PHYS ERROR SURFACE UVIS 2**

Adsorption Isotherm Using a Colorimetric Method: A general chemistry experiment
Dandy, A. J.
J. Chem. Educ. 41, 47 (1964)
CuSO₄ adsorbed on charcoal from water solutions of various concentrations. Cu determined spectrometrically by NH₃. Freundlich isotherm plot. Evaluation of constants, and error analysis.

***PHYS ORG DEMO KIN 3**

Organic Lecture Demonstrations of Common-Ion Effect, Ionizing Power of Solvents, and First-Order Reaction Kinetics
Danen, W. C.; Blecha, Sr. M. T.
J. Chem. Educ. 59, 659 (1982)
Hydrolysis of t-butyl chloride in low aqueous hydroxide solution; kinetics, effect of chloride ion, solvent polarity. A Tested Demo.

***PHYS GAS VACTEK 3**

Determination of Compressibility Factor: An experiment for physical chemistry
Dannhauser, W.
J. Chem. Educ. 49, 563 (1972)
Vac. and gas manifold. He, N₂, CO₂ (compressed gases). Gives measure of non-ideality, Van der Waals' constants, etc.

***PHYS CALORIMETRY KEQ PHASE SOLID THERMO VACTEK VAPORPRESS 3**

Phase Equilibrium, Chemical Equilibrium, and a Test of the Third Law: Experiments for physical chemistry
Dannhauser, W.
J. Chem. Educ. 57, 681 (1980)
Reaction is K₄Fe(CN)₆·3H₂O (solid) to K₄Fe(CN)₆ (solid) and 3H₂O (gas). Standard delta S (298K) determined both by calorimetric and vapor press. vs. temp. measurements. Comparison tests Third Law. Simple apparatus described. Good discussion of student problems with procedures and calculations. Requires at least two five hour lab. periods.

***PHYS ORG APPARATUS KIN 3**

A Simple and Inexpensive Constant Temperature Bath: Its Use in an Undergraduate Kinetics Experiment
Dannley, R. L.; Friedman, L.
J. Chem. Educ. 53, 265 (1976)
For temps. -81 to 100 deg. Celsius. Depends on refluxing liquids. 20 suggested safe refluxing liquids tabulated. Msmnt. of 1st order rates and activation energies for the hydrolysis of C3 to C6 omega-hydroxyalkyl chlorides by titration.

***PHYS ESR PREP PROJ QUANTUM 4 5 HAZARD**

A Versatile Chemical System for Instruction in ESR Spectroscopy
Darcy, R.
J. Chem. Educ. 57, 907 (1980)
N-Hydroxyimidazolidine synthesized and used to prepare five long-lived delocalized pi-radicals. Room temp. ESR spectra presented, analysed. Synthetic procedures described. HAZARD: several of reagents used are poisons.

***PHYS APPARATUS DEMO GAS 2**

Boyle's Law
Davenport, D. A.
J. Chem. Educ. 56, 322 (1979)
Ultrasimple apparatus for effective demo based on hypodermic syringe and household scales.

***PHYS GAS THERMO VAPORPRESS 2**

Experiments With Butane Lighter Fluid
Davenport, D. A.
J. Chem. Educ. 53, 306 (1976)
1) Average molecular weight of butane fluid, 2) use of tire gauge to measure the vap. pressure as a function of temp, 3) molar heat of combustion, by measuring temp. rise in water.

***PHYS APPARATUS DIFFUSION GAS 2**

Hypodermic Syringes in Quantitative Elementary Chemistry Experiments:
1. The gas laws
Davenport, D. A.
J. Chem. Educ. 39, 252 (1962)
Thirty milliliter syringe demonstrates Boyle's, Charles' laws, Dalton's law of partial pressures and, with a specially constructed pierced plug, Graham's law of diffusion.

***PHYS ANAL APPARATUS DENSITY GAS KIN SOLUB VAPORPRESS 2**

Hypodermic Syringes in Quantitative Elementary Chemistry Experiments
2. General Chemistry Experiments
Davenport, D. A.; Sava, A. N.
J. Chem. Educ. 39, 617 (1962)
Techniques for studying gas densities, analysis of mixtures (by absorbents), solubilities of gases in liquids, liquefaction of gases, vapor pressures of liquids, rates of reaction (NaBH₄ hydrolysis), NO₂-N₂O₄ equilibrium. See also Groetz and Gauerke (1971).

***PHYS ELECTROCHEM KEQ PH THERMO 3**

The Determination of the pK of the Dihydrogen Phosphate Ion;
A student experiment.

Davies, I. R.; Serjeant, E. P.; Warner, A. G.

J. Chem. Educ. 54,649 (1977)

Intended for Honors sophomores. Thermodynamic validity and accuracy of measurement are stressed.

***PHYS GRAVIM KIN 3 HAZARD**

The Dissolution of Tin in Solutions of Iodine: A kinetic experiment

Davies, J. F.; Trotman-Dickenson, A. F.

J. Chem. Educ. 43,483 (1966)

Tin metal is suspended (thread) from balance arm, allowed to hang in 12% benzene solution of different concentrations. Rates are followed by changing weight. HAZARD: benzene (avoidable).

***PHYS APPARATUS SURFACE VACTEK 4**

Gas-Solid Interactions: An experiment designed for undergraduate students

Davis, B. W.; Saban, G. H.; Moran, T. F.

J. Chem. Educ. 50,219 (1973)

Requires 12-18 hrs. N₂ adsorption on carbon-black at 77 deg. K. BET theory.

***PHYS APPARATUS COLOR PROJECT SOLAR THERMO 1**

Solar Energy Experiment for Beginning Chemistry

Davis, C. E.

J. Chem. Educ. 60,158 (1983)

Simple homemade apparatus for measuring the energy absorption of various dye solutions. A pyrometer is required. The experiment has "surprise value" in that the students discover that this alternate energy source is highly inefficient. Electrolysis apparatus powered by Si photovoltaic cells also discussed. Intended for a "Chemistry & Environment" course. 1 lab period.

***PHYS ORG CATAL KIN NATPROD POLARIM 3**

Acid-Catalyzed Hydrolysis of Sucrose: A student study of a reaction mechanism.

Dawber, J. G.; Brown, D. R.; Reed, R. A.

J. Chem. Educ. 43,34 (1966)

When carried out at varying acid concentrations, this well-known "pseudo-first order" reaction can be shown to be unimolecular. Hammett acidity function. See also p. 68.

***PHYS ORG KIN NOPROC REFRACT TAUTOMERS THERMO 3**

Keto-Enol Tautomerization: A Thermodynamic and Kinetic Study

Dawber, J. G.; Crane, M. M.

J. Chem. Educ. 44,150 (1967)

Report of data taken by students on rate and extent of enolization of acetoacetic ester and acetylacetone at different temperatures by enol bromination method. Molar refraction was not a satisfactory quantitative method.

***PHYS GAS 1 2 HAZARD**

Ideal Gas Laws: Experiments for general chemistry

Deal, W. J.

J. Chem. Educ. 52,405 (1975)

Several modifications of simple experiments. For example, gas sample from lecture bottle is weighed at ambient T, P to calculate R.

HAZARD: protect students from exposure to liq. or vap. Hg.

***PHYS ELECTROANAL ELECTRODE 4 5**

An Electrochemical Experiment Using an Optically Transparent Thin Layer Electrode.

DeAngelis, T. P.; Heinerman, W. R.

J. Chem. Educ. 53,594 (1976)

Gold mesh-glass sandwich. Construction of electrode detailed and use in cyclic voltammetry, coulometry, spectroelectrochemistry described.

Descriptions sparse, but adequate for advanced course.

***PHYS DRYLAB QUANTUM RAMAN 4**

Raman Spectra of ZYX3 Compounds: A dry-lab spectral analysis experiment

DeHaan, F. P.; Thibeault, J. C.; Ottensen, D. K.

J. Chem. Educ. 51,263 (1974)

Raman spectra of two molecules given. Elucidation requires group theory and prediction of all spectra of all configurations.

***PHYS ANAL COORD CRYO ERROR STOICH TITN 3**

Cryoscopic Measurement of the Coordination Number of Copper(II)

DeLorenzo, H. C.; Frugoni, J. A. C.; Lopez, V.

J. Chem. Educ. 46,113 (1969)

F. pt. depression of aq. copper ammine sulfate gives coord. number.

NH₃ analysis by acid tit'n; copper by iodimetry.

***PHYS APPARATUS HITEMP HPRESS KIN VACTEK 3**

Kinetics of The Gas Phase Pyrolysis of 1,1-Dichloroethane: A physical chemistry experiment
Demare, G. R.; Goldfinger, P.; Huybrechts, G.; Olbregts, J.; Toth, M.
J. Chem. Educ. 46,684 (1969)
Rates followed by pressure increase to approx. 100 torr, 400-460 deg. C.

***PHYS FLUOR KIN LUMIN 3**

Luminescence Spectroscopy and Bimolecular Quenching: A physical chemistry experiment
Demas, J. N.
J. Chem. Educ. 52,677 (1975)
Absorption, excitation and emission spectra and kinetics of quenching of bright orange luminescence of tris-(2,2'-bipyridine)ruthenium chloride by $K_4Fe(CN)_6$. Other quenching reagents can be followed visually or instrumentally. Requires spectrofluorimeter.

***PHYS APPARATUS FASTREACTION KIN LUMIN 4**

Luminescence Decay Times and Bimolecular Quenching: An Ultrafast Kinetics Experiment.
Demas, J. N.
J. Chem. Educ. 53,657 (1976)
Detn of decay time of tris(2,2'-bipyridine)ruthenium(II) ion in oxygenated and deoxygenated water. Mean lifetime approx. 600 nanoseconds. Flash lamp firing circuit schematic and sketch given. Oscilloscope. Could use pulsed N₂ laser. Good discussion.

***PHYS CATAL DEMO KIN LUMIN OSC.RXN 2 3**

An Oscillating chemical reaction with a luminescent indicator
Demas, J. N.; Diemente, D.
J. Chem. Educ. 50,357 (1973)
 $Ru(bipy)_3Cl_2$ (luminescent), malonic acid, $KBrO_3$, H_2SO_4 . color cycle visualized by UV in darkened room.

***PHYS AVOGADRO 1**

Size of a Molecule - or What's in a Shape?
Demchik, M. J.; Demchik, V. C.
J. Chem. Educ. 48,770 (1971)
In a variation on the classic experiment for the determination of Avogadro's number from the height of an oil film, the water layer is acidified causing the molecules to tip over. Thus when the water layer is acid, the height of the film is the cross-sectional diameter of the molecules.

***PHYS DIFFUSION UVIS 3**

A Quantitative Diffusion Experiment for Students
DePaz, M.
J. Chem. Educ. 46,784 (1969)
Permanganate diffuses from one end into 2 mm tube filled with water. Colorimetric measurement at various heights and times. Discussion of errors.

***PHYS CRYO DENSITY TECHNIQUE 4**

Flow Densimetry: A Simple Analytical Technique for Activity Measurements by Freezing Point Data
Desnoyers, J. E.; Ostiguy, C.; Perron, G.
J. Chem. Educ. 55,137 (1978)
Commercial flow densimeter, quartz thermometer. Not described as a student experiment, but could be adapted.

***PHYS MAGNETIC NMR 3**

The Determination of Paramagnetic Susceptibility by NMR: A physical chemistry experiment
Deutsch, J. L.; Poling, S. M.
J. Chem. Educ. 46,167 (1969)
Iron in two oxidation states, complexed and uncomplexed, influences bulk magnetic suscept. and thus proton shifts of an inert substance (t-butyl alcohol). Temp. variation also. Coaxial nmr tubes.

***PHYS DRYLAB IR QUANTUM 4**

Infrared Spectroscopy of Spherical Top (Td) Molecules
DeVore, T. C.; Gallaher, T. N.
J. Chem. Educ. 60,522 (1983)
Exptl. method depends on instrument available. Group theory is used to identify active modes of vibration. Spectrum and analysis given for $TiCl_4$. 2 lab periods. Good discussion of theory.

***PHYS POLYMER NOPROC THERMO 2 3**

A Freshman Chemistry Thermodynamics Experiment: The Cyclic Rule Revisited
Dezube, B.
J. Chem. Educ. 56,313 (1979)
Mathematical and experimental treatment of force, elongation, and temperature of a rubber band. Thermodynamic principles. For instructors.

***PHYS DEMO ENVIRON SURFACE 2**

Removal of Crude Oil from Marine Surfaces: An ecological lecture experiment
Dieteren, H. M. L.; Schouteten, A. P. H.
J. Chem. Educ. 49,19 (1972)
One method is to sink the oil by spraying it with sand treated with a surfactant. Demo investigates effect of amine surfactant at various concentrations, pH, etc.

***PHYS ELECTROCHEM 2**

An Experiment with Galvanic Cells: For the general chemistry laboratory
Dillard, C. R.; Kammeyer, P. H.
J. Chem. Educ. 40,363 (1963)
Simply constructed test tube cell of copper, copper sulfate, salt bridge, metal, metal ion solution, for a general chemistry class or a project.
Comparing two different cells allows ranking in electromotive series.
Better to use a simple meter. Has been used at RPI.

***PHYS DEMO ELECTROCHEM SOLAR 1**

Electroplating With Solar Energy
Dix, G. F.; Hultsch, R. A.
J. Chem. Educ. 55,259 (1978)
Three commercial 0.5V silicon solar cells used to plate a nail with nickel.
Monitor current and time.

***PHYS DEMO ELECTROCHEM OSMOSIS SURFACE 3**

Electro-Osmosis as a Demonstration Experiment: Coupled irreversible effects and direct energy conversion
Dixon, J. R.; Schafer, F. W.
J. Chem. Educ. 43,380 (1966)
Requires sensitive DC volt-ammeter, otherwise simple. Good student project.

***PHYS INORG COMPUTER INTEGR KIN ORGANOMETAL 4 HAZARD**

The Kinetics and Mechanism of a Metal Carbonyl Substitution Reaction
Dobson, G. R.; Paxson, J. R.
J. Chem. Educ. 49,67 (1972)
Prepn (2,5-dithiahexane)tetracarbonylchromium(0) and molybdenum(0) analogue, and kinetics of reaction with triethylphosphite. Spec-20.
Air-sensitive, work under N₂ (app.described). NMR,MASSPEC,IR,UVIS, parameters given. Explicit exptl details. HAZARD: toxic compounds

***PHYS APPARATUS HITEMP KEQ 5**

Estimating The Ionization Constants of 4-Chloro-2,6-Dinitro Phenol; High Temperature Spectrophotometric Cell
Dobson, J. V.
J. Chem. Educ. 48,697 (1971)
Equipment designed to allow determination of ionization constants of weak acids and bases to 200 deg. C. and 1000 psi.

***PHYS HEAT MASSPEC THERMO 4**

The Bond Energy of CH₃-H: A Physical Chemistry Experiment
Dorain, P. B.
J. Chem. Educ. 56,622 (1979)
Varian EM 600 mass spectrometer. Appearance potentials of ethyl cation derived from ethane, and from propane measured. Given heats of formation of reacting and product species, dissociation energy of the CH₃-H bond is easily calculated.

***PHYS ANAL POLARIM PROJ 1 2**

A Simple Polarimeter and Experiments Utilizing an Overhead Projector
Dorn, H. C.; Bell, H.; Birkett, T.
J. Chem. Educ. 61,1106(1984)
Student constructed polarimeter uses Polaroid sunglass lenses. Sugars and terpenes are analyzed by specific rotation. An easy student project.

***PHYS ORG COORD KEQ KIN UVIS 3**

A Spectrometric Study of The Oxidation of Alcohols by Cerium(IV)
Doyle, M. P.
J. Chem. Educ. 51,131 (1974)
To establish mechanism, measure Keq for complex formation (one lab period) and kinetics of complex decomposition (groups, one additional period).

***PHYS CATAL DEMO KIN REDOX 2**

Autocatalysis
Dreisbach, D. A.
J. Chem. Educ. 35, A29 (1958)
Reaction of KMnO₄ with oxalic acid is catalyzed by Mn⁺⁺ ions.
A Chem-Ed Tested Demo.

***PHYS DEMO THERMO VAPORPRESS 2 HAZARD**

Measuring the Heat of Vaporization Using the Clausius-Clapeyron Equation
Driscoll, J. A.

J. Chem. Educ. 57,667 (1980)

Simple steam jacketed Hg barometer used to measure vapor pressures at room and steam temps. Delta enthalpy derived from Clausius-Clapeyron equation.

HAZARD: liquid Hg could be especially hazardous if apparatus breaks while at steam temp.

***PHYS APPARATUS COMPUTER ERROR FLUOR KIN LASER QUANTUM VACTEK 4 5**

Quenching of I2 Vapor Fluorescence Excited With He-Ne Laser Light: A kinetics-spectroscopy experiment

Duchin, K. L.; Lee, Y. S.; Mills, J. W.

J. Chem. Educ. 50,858 (1973)

Requires laser, photomultiplier tubes, all Teflon, Hg-free vacuum syst. with high volt. power supply, recording electrometer. Stern-Volmer kinetics for self-quenching. Project: foreign gas quenching, fluorescence polarization study.

***PHYS ORG ACBA KIN NOPROC PREP TITN 3**

Kinetic Studies of The Solvolysis of Two Organic Halides: A laboratory project

Duncan, J. A.; Pasto, D. J.

J. Chem. Educ. 52,666 (1975)

Rates of solvolysis of 2-chloro-2-methylpropane and 3-chloro-3-methyl-1-butyne (prep. given) in 80% ethanol-water. Effect of temp, salt, base.

Followed by titration. Needs three 4-hr. periods. Lab report form given.

***PHYS NOPROC SURFACE 4**

Surface Area of Activated Charcoal by Langmuir Adsorption Isotherm

Dunicz, B. L.

J. Chem. Educ. 38,357 (1961)

Not an experiment. Modification of data treatment to find specific adsorption area.

***PHYS APPARATUS CALORIMETRY 3**

Water Equivalent of Vacuum Flask Calorimeter by the Ice Fusion Method

Dunicz, B. L.

J. Chem. Educ. 37,635 (1960)

Straightforward. Dewar flask calorimeter.

***PHYS CRYSTAL MICROSCOPE NOPROC UVIS 4**

Measurement of the Order Parameter in a Room Temperature Liquid Crystal: An Experiment for the Physical Chemistry Laboratory

DuPre, D. B.; Chapoy, L. L.

J. Chem. Educ. 56,759 (1979)

Detn of degree of orientational order at room temp; order disappears at higher temp. Detn of dichroic ratios. p-Methoxybenzylidene-p'-N-butylaniline (commonly called MBBA). Spectrophotometer. Polarizing microscope.

***PHYS DEMO PHASE 2**

Lecture Demonstration of Vanishing Meniscus in Vapor-Liquid Transition

Duus, H. C.

J. Chem. Educ. 56,614 (1979)

Detailed description of construction and filling of glass containing tube. Liquid propane.

***PHYS CLOCK DEMO KIN 2**

A Versatile Clock Reaction

Dye, J. L.

J. Chem. Educ. 37,A22 (1960)

Sodium persulfate/potassium iodide in a standard iodine-clock exp't, converted to a demo. Cu++ is added to a "control" sample to observe change in kinetics. No explanations - just directions for preparation of the solutions.

***PHYS APPARATUS CRYO DECAY PHOSPHOR 4 HAZARD**

An Undergraduate Experiment For The Measurement of Phosphorescence Lifetimes

Dyke, T. R.; Muentzer, J. S.

J. Chem. Educ. 52,251 (1975)

Requires strobe lamp, filters, photomultipliers, oscilloscope. Measurements on biacetyl, halogenated naphthalenes. Some exp'ts in EPA glass at liq. N2 temp. HAZARD: benzene used as a solvent is carcinogenic.

***PHYS AA-FP KSP TECHNIQUE 4**

The Solubility Curves for Calcium and Strontium Sulfates

Dyrssen, D.; Ivanova, E.; Aren, K.

J. Chem. Educ. 46,252 (1969)

A Bronsted saturator is a simple apparatus to give equilibrium solubility of solids in a flame system. Analysis by atomic absorption for Ca, Sr, Na. The effect of ion pairing causing deviation makes the calculations not trivial. Constant temp.

***PHYS ESR 4**

EPR Studies of Spin-Spin Exchange Processes: A Physical Chemistry Experiment

Eastman, M. P.

J. Chem. Educ. 59, 677 (1982)

Line-width study: broadening observed in a spin-spin exchange process between radicals formed in aq. solutions of potassium peroxyamine disulfonate. Prep. by ref. Good theoretical discussion.

***PHYS INORG APPARATUS DEMO MAGNETIC 2**

An Inexpensive, Convenient Demonstration of Magnetic Susceptibility

Eaton, S. S.; Eaton, G. R.

J. Chem. Educ. 56, 170 (1979)

Construction of an inexpensive, small magnetic balance similar to a Gouy balance described but measuring the weight change of a small, powerful magnet on the balance pan with fixed sample between poles. Uses Hitachi-Hicorex magnets. (ie, the small strong ones you can get from Edmund Scientific).

***PHYS CALORIMETRY DEMO ELECTROCHEM THERMO 2**

Two Lecture Experiments in Elementary Thermodynamics

Eberhardt, W. H.

J. Chem. Educ. 47, 362 (1970)

(1) Heat of vaporization of methylene chloride by calorimetry (apparatus described); (2) voltage of an electrochemical cell constructed from two half cells: A. (Ag/0.2F Ag⁺), and B. (Cu/0.2F Cu⁺⁺), so as to show reversible and irreversible processes.

***PHYS DEMO ELECTROCHEM 2**

Electrolysis: H₂O₂ and H₂O

Eberhardt, W. H.

J. Chem. Educ. 41, A59 (1964)

Hoffman electrolysis apparatus required. H₂SO₄ containing 3% H₂O₂ gives less H₂ than H₂SO₄ solutions. A Chem-Ed Tested Demo.

***PHYS DEMO THERMO 2**

Concerning Equilibrium, Free Energy Changes, LeChatelier's Principle II.

Eberhardt, W. H.

J. Chem. Educ. 41, A59 (1964)

Pink-blue cobalt solutions. A Chem-Ed Tested Demo. See Grant, A. W., Jr., J. Chem. Educ., 61, 466 (1984) for a corrected mechanism.

***PHYS COORD KIN NOPROC REDOX UVIS 2**

The Reactions of Ferriox Complexes: A Color-to-Colorless Freshman Kinetic Experiment

Edwards, J. O.; Edwards, K.; Palma, J.

J. Chem. Educ. 52, 408 (1975)

Student is to follow rate of disappearance of ferrous o-phenanthroline on reaction with various reagents (acid, cupric, pyrophosphate, peroxydi-phosphate, etc.), also ferrous 5-nitrophenanthroline and bipyridyl complexes, spectrophotometrically.

***PHYS DEMO PHASE VAPORPRESS 2**

Raoult's Law and Vapor Pressure Measurement

Egen, N.; Ford, P. C.

J. Chem. Educ. 53, 303 (1976)

Mercury column-meter stick expt. Ether, ether-toluene mixture. Compare calculated v.p. to measured. A tested demonstration. Caution: Hg vapor.

***PHYS ORG DEMO KIN 2 HAZARD**

Temperature Effect on Reaction Rates

Elison, R.; McMahon, T.

J. Chem. Educ. 58, 354 (1981)

A Tested Demo suitable for indiv. project; the reaction of dibenzoyl peroxide (explosive HAZARD) with aniline.

***PHYS ACBA FLUOR UVIS 3**

Excited-State Dissociation: Laboratory exercise using fluorescence

Ellis, D. W.

J. Chem. Educ. 43, 259 (1966)

Acidities of phenols and ammonium salts greater in excited states.

Measure absorption at uv and vis. maxima and also with exciting radiation in a filter fluorometer.

***PHYS ORG ACBA DISTRIB PHASE TITN 3 HAZARD**

Simultaneous Equilibria in the Benzoic Acid-Benzene-Water System :

A distribution experiment

Elison, H. R.

J. Chem. Educ. 48, 124 (1971)

System is characterized by 3 equilibria, (1) distribution of benzoic acid between benzene and water, (2) ionization of benzoic acid in aq. phase, (3) dimerization of acid in benzene phase. Titrations with NaOH used to find relevant constants. HAZARD : benzene is carcinogen - maybe toluene would be satisfactory.

***PHYS COMPUTER CRYO PHASE THERMO 3**

Binary Solid-Liquid Equilibria

Ellison, H. R.

J. Chem. Educ. 55,406 (1978)

The naphthalene, p-dichlorobenzene system is used to find enthalpy of solution and freezing point lowering constants.

***PHYS GAS KIN 3**

A Simplified Apparatus for Gas Phase Reactions: Decomposition of di-t-butyl peroxide

Ellison, H. R.

J. Chem. Educ. 48,205 (1971)

Simplification of experiments described earlier (references given).

***PHYS ANAL IONSELECT KEQ 3**

Ionic Association: Ion-Selective Electrode Experiment

Emara, M. M.; Farid, N. A.; Lin, C. T.

J. Chem. Educ. 56,620 (1979)

Commercially available solid state selective electrode and pH meter used to determine the stability constants of sodium sulfate in aq. solution at varying ionic strengths.

***PHYS CRYO PHOSPHOR PHOTO QUANTUM UVIS 4**

Phosphorescence and Energy Transfer in Rigid Solutions

Enciso, E.; Cabello, A.

J. Chem. Educ. 57,323 (1980)

Triplet-triplet energy transfer. Benzophenone(donor)- naphthalene(acceptor) in ethanol-ether solutions at 77K. Simple photodiode circuit described to measure phosphorescence intensity. Electron energy level diagram given.

Dark room required. Caution: UV radiation, eye hazard; liquid nitrogen, frostbite; solvents, fire hazards.

***PHYS DEMO NOPROC PHASE PREP REDOX THERMO 2**

Aluminothermic Reduction : An illustrative experiment

Espelund, A. W.

J. Chem. Educ. 52,400 (1975)

Procedure is well-described but not given explicitly. Detailed discussion of thermodynamics and phase diagrams, (1) simple charge ($\text{Fe}_3\text{O}_4 + \text{Al}$), and (2) slag-containing charge ($\text{Fe}_3\text{O}_4 + \text{Al} + \text{CaO}$). Caution: high temperatures and explosive potential.

***PHYS DEMO ELECTROCHEM SOLAR 1**

A Simple and Inexpensive Solar Energy Experiment

Evans, J. H.; Pedersen, L. G.

J. Chem. Educ. 56,339 (1979)

Measured amounts of hydrogen gas are generated electrochemically and measured amounts of water pumped thru a vertical distance to measure power vs. load of a solar panel.

***PHYS ELECTROCHEM 2**

Verification of The Form of The Nernst Equation: An experiment for introductory chemistry

Evans, J. S.

J. Chem. Educ. 45,532 (1968)

$\text{Ag}/\text{Ag(I)}/\text{Fe(II)}/\text{Fe(III)}/\text{Pt}$ used to measure concentration dependence of voltage, to establish form of equation. Salt bridge is KNO_3 -wet filter paper. Requires high-impedance voltmeter.

***PHYS APPARATUS DIFFUSION GAS TRANSPORT 3**

Graham's Laws: Simple Demonstrations of Gases in Motion

Part II. Experiments

Evans, R. B.; Ill, Love, L. D.; Mason, E. A.

J. Chem. Educ. 46,423 (1969)

Open-ended. Requires some special glass-blowing. Easy calculations. Transport properties. Diffusion. Permeability.

***PHYS ORG BIOCHEM KIN 4 HAZARD**

Reaction Kinetics: An experiment for biochemistry and organic chemistry laboratories

Ewing, S.

J. Chem. Educ. 59,606 (1982)

Decomposition of sodium p-nitrophenylcarbamate to p-nitroaniline followed at 400 nm (Spec-20). Effect of concentration of buffer on reaction rate also studied. Unidentified HAZARD: dioxane (carcinogen).

***PHYS MASSPEC 4**

Appearance Potential Measurements by Mass Spectrometry: A physical chemistry experiment

Fass, R. A.; Kendall, S. G.

J. Chem. Educ. 48,545 (1971)

One 6-hr. lab; small groups of students, methane-argon samples, Perkin-Elmer RMO-6D, and a trained technician.

***PHYS APPARATUS VAPORPRESS 3**

Measurement of Vapor Pressure: A Gas Saturation Method
Feighan, J. A.

J. Chem. Educ. 37,149 (1960)

VP of water, common alcohols. N₂ carrier bubbled through liquids at various rates. Sintered glass gas dispersion unit. Vapor absorbed, or condensed and weighed.

***PHYS GAS 1**

A Dalton's Law Experiment For Students in The Health Sciences

Feigl, D. M.

J. Chem. Educ. 51,273 (1974)

Measurement of CO₂ pressure in inhaled and exhaled air by pressure drop when CO₂ absorbed in 10% NaOH. Simple apparatus.

***PHYS APPARATUS DEMO ELECTROCHEM FUELCELL 2**

The Electrolysis of Water - Fuel Cell Reaction

Feinstein, H. I.; Gale, V.

J. Chem. Educ. 54,432 (1977)

Inexpensive apparatus. Illustrates the electrolysis of water and its reverse (fuel cell) reaction. A tested demonstration.

***PHYS PHASE 1 2 HAZARD**

Evaporation Rate: A beginning chemistry experiment

Feinstein, H. I.; Walters, C.

J. Chem. Educ. 49,135 (1972)

A short note on a simple beginning experiment. HAZARD: suggested solvents include CHCl₃, benzene (carcinogens, avoidable).

***PHYS INORG DEMO KIN 2**

Chemical Kinetics: The Effect of Surface Area on Reaction Rate

Felice, M. S.; Freirlich, M. B.

J. Chem. Educ. 55,34 (1978)

"Eyeball" comparison of rates of reaction of (1) I₃⁻ with mossy or granulated tin; (2) MnO₄⁻ with Fe filings or Fe wire; (3) HNO₃ with Cu powder or Cu wire.

***PHYS ANAL ACBA DEMO KEQ PH 2**

Buffer Action with Precise pH Monitoring

Felty, W. L.

J. Chem. Educ. 53,229 (1976)

Digital pH meter measures pH of various mixtures of acetates, phosphates, acid, etc.

***PHYS APPARATUS CALORIMETRY NOPROC THERMO 3**

A Thermistor Bridge Using Light-Emitting Diodes: An undergraduate thermochemistry experiment

Ferguson, A. M.; Phillips, L. F.

J. Chem. Educ. 50,684 (1973)

Enthalpies of neutralization; emphasis on construction of thermistor bridge circuit.

***PHYS CATAL DEMO KIN OSC.RXN 2**

A Reaction Periodic in Time and Space: A lecture demonstration

Field, R. J.

J. Chem. Educ. 49,308 (1972)

Ce(IV)-Ce(III), malonic acid, KBrO₃, H₂SO₄, ferroin (Belousov Reaction).

Detailed discussion of autocatalytic reactions and oscillating systems.

For suggestions for kinetic studies using osc. rxn. see Rawaswamy, R. et al, J. Chem. Ed., 56, 321 (1979).

***PHYS INORG CATAL DEMO KIN OSC.RXN REDOX 2**

Travelling Waves of Chemical Activity in the Zaikin-Zhabotinskii-

Winfrey Reagent

Field, R. J.; Winfree, A. T.

J. Chem. Educ. 56,754 (1979)

Oscillating reaction. Reaction of ferroin with malonic acid in the presence of a surfactant oscillates. Apparatus to show "waves"

described, using overhead projector.

***PHYS KIN REDOX TITN 2 HAZARD**

Oxidation of Ethanol by Chromium(VI): A kinetics experiment for freshmen

Finlayson, M. E.; Lee, D. G.

J. Chem. Educ. 48,473 (1971)

Explicit directions. H₂CrO₄ conc. followed by titn. Na₂S₂O₃. HAZARDS: Chromic acid is on OSHA list of carcinogens; highly exothermic reaction.

***PHYS ANAL COORD KSP PROJ SOLUB 3**

Student Research Experiment With Multiple Equilibria

Fleck, G. M.

J. Chem. Educ. 42,106 (1965)

Student designed approaches to the lead-lead chloride solubility equilibria (complex ions involved). Caution: Pb is an embryotoxin.

***PHYS DEMO DISTRIB PHASE 2 HAZARD**

A Visual Demonstration of Preferential Absorption

Folster, H. G.

J. Chem. Educ. 49,322 (1972)

Note on an elementary demo for stage separations course. HAZARDS:

(1) Shield blender contents from sparks. (Fire). (2) CCl₄ is a suspected carcinogen.

***PHYS COMPUTER IR MOLSPEC PROJ QUANTUM VACTEK 4**

Determination of The Vibrational Constants of Some Diatomic Molecules: A Combined Infrared Spectroscopic and Quantum Chemical 3rd yr. Chemistry Proj.

Ford, T. A.

J. Chem. Educ. 56,57 (1979)

Advanced molecular spectroscopy. Absolute intensities, as well as high high-resolution ir spectra. Uses standard gas cell, HCl, HBr, CO, NO. Ten 3-hr lab periods.

***PHYS ACBA NATPROD PH 0**

Plant Pigments as Acid-Base Indicators. An Exercise for Junior High School

Forster, M.

J. Chem. Educ. 55,107 (1978)

Straightforward. Anthocyanin pigments extracted from leaves (e.g. red cabbage) with hot water. Various household acids, bases used to show color changes.

***PHYS ANAL ACBA KEQ UVIS 2**

Colorimetric Determination of the Dissociation Constant of Acetic Acid

Forst, W.

J. Chem. Educ. 36,298 (1959)

The color of a methyl orange solution is used as a measure of hydrogen ion concentration. Spec-20.

***PHYS CATAL KIN POLARIM 3**

Determination of Catalytic Coefficient For a First-Order Reaction: An undergraduate physical chemistry experiment

Fraga, E. R.; Schifano, J.; Gomez, I.

J. Chem. Educ. 52,749 (1975)

Hydrolysis of sucrose followed with a polarimeter at low acid conc.;

"catalytic coefficient" is dependence on H(+) conc. See also Dawber, et al, J. Chem. Educ. 43, 34 (1966).

***PHYS COMPUTER DRYLAB NOPROC QUANTUM 3**

A Computer Assisted Experiment in Quantum Mechanics: A physical chemistry laboratory and/or lecture

Frankel, E. C.; Davis, D. D.

J. Chem. Educ. 50,80 (1973)

Calculation of ionization potentials of closed shell atoms by Hartree-Fock.

Requires programming experience in Fortran.

***PHYS ASSOC COLLOID MICELLE 3**

A Simple Experiment Illustrating the Structure of Association Colloids

Friberg, S.; Bendikson, B.

J. Chem. Educ. 56,553 (1979)

Sodium dodecyl sulfate (a surfactant) solutions are treated with (1) octane, and (2) pentanol, added in small increments. After each addition the solutions are tested for transparency, behavior in polarized light, electrical conductance. Micelle formation and solubilization of some octane and much pentanol are noted, also inverse micelle formation.

***PHYS DEMO PHASE 1 2**

Le Chatelier's Principle: A Laboratory Exercise

Friedman, F.

J. Chem. Educ. 54,236 (1977)

Chem.Ed. Compact. Showing how water can boil below 100 deg. Celsius. Simple apparatus.

***PHYS CALORIMETRY THERMO 2**

Hydrogen Bonding And Heat of Solution

Friedman, N.

J. Chem. Educ. 54,248 (1977)

Temperature rise and (with some refinements) heat of solution of ethanol, dimethylsulfoxide and dimethylformamide. Student calorimeter.

Caution: DMSO absorbs thru skin, carrying in contaminants.

***PHYS INORG DEMO ELECTROCHEM 2**

Electrode Potentials With a Vacuum Tube Voltmeter
Gachis, L.

J. Chem. Educ. 38 ,A63 (1961)

Half-cells are constructed by slashing a filter paper circle into quadrants. On each, a splotch of met. ion sol'n (eg, CuSO_4) serves as the electrolyte, a small piece of the metal (eg, Cu) serves as the active electrode, and a splotch of an inert electrolyte in the cent. of the filter, joining the met. ion sol'ns, serves as the salt bridge. Poten. bet. the half-cells are meas. with any voltmeter; we use a pH meter (+/-MV) at SUSB. Chem-Ed Tested Demo.

***PHYS DEMO LUMIN REDOX 2 HAZARD**

Chemiluminescence: An illuminating experiment

Gafney, H. D.; Adamson, A. W.

J. Chem. Educ. 52 ,480 (1975)

Direct addition of $\text{Ru}(\text{bipy})_2^{++}$, prepared by PbO_2 oxidation of $\text{Ru}(\text{bipy})_2\text{Cl}_2$, to NaBH_4 solution produces a bright orange flash. Apparatus described for using this reaction as a demonstration. HAZARD: foaming (due to hydrogen evolution?), exothermic.

***PHYS KIN SOLID VACTEK 4**

Thermal Decomposition of KMnO_4 : A high vacuum experiment for students
Galwey, A. K.

J. Chem. Educ. 37 ,98 (1960)

Final-year Honors. Glassblowing, furnace (250 deg. C.). Measure pressure of product gases. Caution: use a safety shield. Samples are explosive.

***PHYS ASSOC CATAL COMPLEX KIN MICELLE SURFACE UVIS 3 4**

Catalysis by Micelles and by Cycloamyloses: A Comparative Set of Kinetic Experiments

Garcia-Mateos, I.; Herrera, M. A.; Rodrigo, M.; Rodriguez, L. J.
Velazquez, M. M.

J. Chem. Educ. 58 ,584 (1981)

Rxn. between hydroxyl ion and nitroethane. Rate studied in sol'ns containing cycloheptaamylose and micelles of cetyl trimethylammonium bromide, sodium lauryl sulfate and polyoxyethylene-23-lauryl ether. Conc. of nitronate anion measured at 230 nm. Results discussed in terms of micelle-hydroxyl and amylose-nitroethane interactions.

***PHYS DEMO THERMO 1 2**

A Practical Energy Experiment or Lecture Demonstration
Garin, D. L.

J. Chem. Educ. 50 ,497 (1973)

Short note describes very simple experiments, more suited for non-science majors, involving many different amounts of water and studying change in temperature, etc., with time.

***PHYS SURFACE TECHNIQUE UVIS 3**

Bubble Fractionation: A physical chemistry experiment

Garmendia, A. A.; Perez, D. L.; Katz, M.

J. Chem. Educ. 50 ,864 (1973)

A stage separations experiment. N2, crystal violet solution, soap film flowmeter. Process is followed colorimetrically; surface tension also measured.

***PHYS ORG GEOM KIN NMR QUANTUM 3**

NMR Determination of The Rotational Barrier in N,N-Dimethylacetamide:

A physical chemistry experiment

Gasparro, F. P.; Kolodny, N. H.

J. Chem. Educ. 54 ,258 (1977)

Variable-temperature probe NMR. Variation in line shape measured as function of temperature (259-368 K). Theory of line shape analysis. Rate of exchange also calculated.

***PHYS IR KIN 4**

Infrared Spectrometry to Study Second Order Kinetics

Gastambide, B.; Blanc, J.; Allamagny, Y.

J. Chem. Educ. 41 ,613 (1964)

Reaction of phenyl isocyanate with menthol is followed by quantitative infrared spectroscopy. Liquid samples. Caution: phenyl isocyanate is a lachrymator, an irritant, possibly a carcinogen.

***PHYS COLORIMETRY KIN 2**

A Simple General Chemistry Kinetics Experiment

Gellender, M.

J. Chem. Educ. 52 ,806 (1975)

Iodide-persulfate. Not a clock exp't. Reaction is followed colorimetrically by observing brown color of triiodide.

***PHYS MOL.SPECT QUANTUM UVIS 2 3**

A Molecular Spectral Corroboration of Elementary Operator Quantum Mechanics
Gerkin, R. E.

J. Chem. Educ. 42,490 (1965)

Measured absorption maxima of a series of polymethine dyes compared with quantum theory calculations of transition energies based on free electron theory (particle in one-dimensional box). Freshman honors at Ohio State— or higher level.

***PHYS GAS KEQ KIN VAPORPRESS 2**

Capillary Tube Experiments For Introductory Chemistry Laboratory

Gesser, H. D.; Lithown, C.; Brattston, D.; Thompson, I.

J. Chem. Educ. 44,387 (1967)

Inexpensive. Designed for large classes. Uniform capillary with Hg-drop plug (piston) in tubing used to measure vap. pressure common alcohols; Keq ammonium carbamate decomp.; kinetics decomp. benzenediazonium chloride.

***PHYS ELECTROCHEM SOLID 2 3**

An Inexpensive Experiment on Semiconductors

Getzin, D. R.

J. Chem. Educ. 48,541 (1971)

Inexpensive experiment for first-year course. Resistance measurements on a small doped germanium bar, temperature coefficients, for N type determination.

***PHYS GAS KIN NOPROC 2**

The Rate of Oxygen Absorption by the Lungs: An Elementary Chemistry Laboratory Experiment for Biology-Oriented Students

Getzin, D. R.; Wysoczynski, W.

J. Chem. Educ. 51,414 (1974)

Short note describes use of commercial(?) oxygen analysis app. Air exhaled is captured in balloons, oxygen content measured after various times. Correlations with age, etc. increase student interest.

***PHYS COMPUTER DRYLAB KIN NOPROC 3 4**

Analog Computer Simulation of the Methanolysis of Acetal
Giachino, G. G.

J. Chem. Educ. 55,201 (1978)

Students use computer to assume rate constants, examine concentration plots (and, at RPI, to compare with gc data from experiment).

***PHYS ORG BIOCHEM CHIRAL ISOMERS KEQ POLARIM 2**

A Polarimeter Experiment for Introductory Courses

Gibas, M. A.

J. Chem. Educ. 53,462 (1976)

Purpose of experiment is to determine the eq. constant for the reaction: α -D-glucose = β -D-glucose by measuring the rotation of solutions of diff. conc. Details by writing.

***PHYS NOPROC PHASE 4**

Variation of Azeotropic Composition and Temperature with Pressure: An undergraduate physical chemistry experiment

Gibbard, H. F.; Emptage, M. R.

J. Chem. Educ. 52,673 (1975)

Theory of azeotropes reviewed and detailed mathematical interpretation of an experiment from Daniels, Exp'l Phys. Chem. (by citation only).

***PHYS APPARATUS HITEMP PHASE TECHNIQUE 4**

A Versatile Hot Stage Microscope:

Lab studies in high temperature chemistry

Glasser, L.; Miller, R. P.

J. Chem. Educ. 42,91 (1965)

Construction and application to phase transition and binary system phase diagrams to 1750 deg. C.

***PHYS ORG CATAL COMPUTER GC ISOMERS KIN NMR 3**

Amine-Catalyzed Isomerization of Diethyl maleate to Diethyl fumarate

Glover, I. T.; Cushing, G. W.; Windsor, C. M.

J. Chem. Educ. 55,812 (1978)

Catalyst conc. and temp. varied. Analysis by gc peak height or nmr integration.

***PHYS DEMO THERMO 1**

Heat of Crystallization

Goeders, C. N.

J. Chem. Educ. 37,A79 (1960)

A Chem-Ed Tested Demo. Unusual, "hands-on" demo: cold, supersaturated Na₂S₂O₃ solutions are given to the students. They must induce crystallization using a stirring rod. Test tubes become hot to the touch.

***PHYS COORD ELECTROANAL KEQ 4 HAZARD**

Formation Constants of a Metal-Anionic Ligand System in Dioxane-Water
Goldberg, D. E.

J. Chem. Educ. 40,341 (1963)

Pot. tit'n, high pH, glass electrode, activity coefficients. Divalent Cu,
Ni complexes with (eg) acetylacetone in dioxane. Titration with
tetramethylammonium hydroxide. Sample calculations. HAZARD: dioxane is
a carcinogen.

***PHYS ASSOC DEMO 1**

Ionic Versus Covalent Bonding

Goldish, D. M.

J. Chem. Educ. 46, A49 (1969)

Simple comparisons of the bonding in chlorine-containing compounds
by testing with AgNO₃. A Chem-Ed Tested Demonstration.

***PHYS IR NOPROC QUANTUM 4 5**

On the Variation of Infrared Absorption Spectra with Gas Pressure and Cell
Length

Goldman, A.; Blatherwick, R. D.

J. Chem. Educ. 57,392 (1980)

The linear (weakline) and square root (strongline) limits of Lambert-Beer
law used to explain pressure-path length effects on weak and strong
adsorption lines in the very high resolution IR spectrum of methane.
Article does not describe a laboratory experiment.

***PHYS KIN SOLID VACTEK 3**

Kinetics of the Thermal Decomposition of Silver Permanganate: A solid
state chemistry experiment

Goldstein, M. K.; Flanagan, T. B.

J. Chem. Educ. 41,276 (1964)

Straightforward. Intended to teach use of vacuum systems. AgMnO₄ was
chosen because of low decomp. temperature. Typical decomp. curves given,
Arrhenius plot. Two or three periods. Extensions suggested.

***PHYS CATAL GC INTEGR NOPROC PROJ SURFACE 3**

A Transition from a Traditional to a Project-Like Physical Chemistry
Laboratory via a Heterogeneous Catalysis Study

Goldwasser, M. R.; Leal, O.

J. Chem. Educ. 56,829 (1979)

Integrated lab syllabus mostly physical, part from J. CHEM. EDUC, followed
by extended project or a heterogeneous catalyst.

***PHYS APPARATUS COORD FASTREACTION FLASHPHOTOL KIN 4**

Relaxation Kinetics of Ferric Thiocyanate: A temperature-jump and
flash-photolysis study

Goodall, D. M.; Harrison, P. W.; Hardy, M. J.; Kirk, C. J.

J. Chem. Educ. 49,675 (1972)

Flash photolysis apparatus described earlier. Circuit diagram for
temperature-jump given. Extensions possible.

***PHYS POLYMER APPARATUS KIN NOPROC PHOTO TECHNIQUE 4**

Flash Photolysis Experiments for Teaching Kinetics and Photochemistry

Goodall, D. M.; Harrison, P. W.; Wedderburn, J. H. M.

J. Chem. Educ. 49,669 (1972)

Much attention to theory, illustrations of slope traces. A number of
possible experiments, some involving polymer matrices are described, and
related projects suggested.

***PHYS ANAL KSP 1 2**

Is The Solubility Product Constant? Introductory experiment in solubility
equilibrium

Goodman, R. C.; Petrucci, R. H.

J. Chem. Educ. 42,104 (1965)

PbI₂ formed from lead nitrate and potassium iodide of varying conc. gives
effect of ion conc. on K_{sp}. Extensions to effect of complex formation.

***PHYS APPARATUS PHASE SURFACE 3 HAZARD**

A Micromethod For Measuring Interfacial Tension

Gordieyeff, V. A.; Hackley, E. B.

J. Chem. Educ. 37,301 (1960)

Mod. of capillary method measuring pressure above capillary eliminates
uniform capillary. Temp. control. Water-organics, as xylene, oleic acid,
etc. HAZARD: avoid the benzene.

***PHYS ELECTROCHEM NOPROC 2 HAZARD**

Some Electrochemical Experiments for Freshmen

Gorman, M.

J. Chem. Educ. 34,409 (1957)

An experiment is described wherein a student identifies the metal of a
(1M Cd++ , Cd) couple, given as an unknown, by constructing a series of
cells using it as one half-cell and a series of known half-cells, such as the
(1M Cu++ , Cu) couple, as the other. Identification is made by obs. the cell
voltage and calc. the SRP of the Cd++ /Cd couple. HAZARD: Cd, extr. toxic.

***PHYS POLYMER CONSUMERPROD ELECTROCHEM REDOX 2 HAZARD**

The Electroplating of Polyethylene

Gorodotsky, M.

J. Chem. Educ. 55,66 (1978)

Polymer film oxidized by chromic acid sensitized by Sn(II), then Pd(II), with Cu(0) plated on the polyethylene from a Cu(II) solution and formaldehyde as the reducing agent.

HAZARD: Chromium is potential carcinogen; possibly HNO₃ as cleaning agent.

***PHYS DIFFUSION GAS GC 4**

Diffusion of Gases: A physical chemistry experiment

Gover, T. A.

J. Chem. Educ. 44,409 (1967)

Special diffusion tube, analysis by GC. Complex theory.

***PHYS APPARATUS FASTREACTION KIN UVIS 3 4**

An Easily Constructed and Inexpensive Stopped-Flow System for Observing Rapid Reactions

Gray, Jr., E. T.; Workman, H. J.

J. Chem. Educ. 57,752 (1980)

Detailed directions for construction and use of inexpensive stopped flow kinetics apparatus using spectrophotometric detection. Suitable for first order rate constants in range 0.001 to 100 sec⁻¹. Tested with Fe(III)-SCN rxn.

***PHYS APPARATUS ELECTROCHEM KIN 3**

Reaction Kinetics From Conductivity Data: An apparatus for the student laboratory

Greenberg, D. B.

J. Chem. Educ. 39,140 (1962)

Inexpensive specially designed conductivity apparatus; circuit diagram. Rate of decomp. of acetic anhydride in water-ethanol. Caution: Ac₂O causes burns.

***PHYS ORG ACBA KEQ NOPROC SEPARATION 2**

Effect of Amine Structure on the Relative Acidity of Conjugate Acids

Griswold, R. E.

J. Chem. Educ. 42,483 (1965)

Student purifies sample of an alicyclic or aryl amine by distillation; det'ns pK_a by method of half-neutralization using a pH meter. Aniline is used as a standard amine.

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***PHYS COMPUTER DRYLAB KIN 3 4**

Analog Computer Simulation

Griswold, R.; Haugh, J. F.

J. Chem. Educ. 45,576 (1968)

Heathkit analog computer programmed by instructor for three step mechanism k₁, k₋₁, k₂. Students adjust initial conc., k values, plot output and calculate.

***PHYS DEMO REDOX 2 HAZARD**

Oxidation and Chemical Environment

Grotz, L. C.

J. Chem. Educ. 54,618 (1977)

Ability of Fe⁺³ to oxidize iodide is inhibited by fluoride ion. Removal of fluoride (as HF) restores oxidizing ability. HAZARD: fluorides in concentrations suggested in this article are toxic; HF is a serious toxic and blister-producing gas.

***PHYS APPARATUS GAS 2**

Boyle's Law With Plastic Syringes

Grotz, L. C.; Gauerke, J. E.

J. Chem. Educ. 48,337 (1971)

Reports successful use of disposable syringes to replace glass syringes in method of Davenport (1962).

***PHYS ANAL COORD KEQ TITN 3**

Stepwise Formation Constants of Complex Ions: A student experiment

Guenther, W. B.

J. Chem. Educ. 44,46 (1967)

Ammonia complexes of Ni(II), Ag(I), Zn(II), etc. by pH.

***PHYS KIN VACTEK 3**

Kinetics of The Gas Phase Decomposition of Di-Tert-Butyl Peroxide

Guillory, W. A.

J. Chem. Educ. 44,514 (1967)

Requires previous preparation of di-tert-butyl peroxide (ref.). First order. Constant volume system, followed by pressure increase. 2-3 hours. See also Ellison, H.R., J. CHEM. EDUC., 48, 205 (1971) for a simplified apparatus.

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***PHYS APPARATUS CRYO GAS IR QUANTUM 4**

The Infrared Spectra of Gases at 300 deg K and of Frozen Films at 77 deg K:
A physical chemistry experiment
Guillory, W. A.
J. Chem. Educ. 46,681 (1969)
N₂O, SO₂, CH₂Cl₂, CO₂. Modified Hornig-type gas cell.

***PHYS FASTREACTION KIN 3**

Flowing Clock Reactions
Haggett, M. L.; Jones, P.; Oldham, K. B.
J. Chem. Educ. 40,367 (1963)
Simple apparatus to measure reaction rates of formaldehyde clock and iodine clock.

***PHYS KIN UVIS 2 3**

The Tin(II)-Methyl Orange Reaction: A kinetics experiment for introductory chemistry
Haight, G. P., Jr.
J. Chem. Educ. 42,478 (1965)
Stoichiometry is 2 tin to 1 MO. Kinetics are first order in each reagent and in H⁺. Air oxidation and tin(II)-chloride complexation make for serious problems. Followed colorimetrically. Open-ended.

***PHYS ANAL KEQ NMR PH 4**

Experimental Determination of pK_a Values by Use of nmr Chemical Shifts
Handloser, C. S.; Chakrabarty, M. R.; Mosher, M. W.
J. Chem. Educ. 50,510 (1973)
Water-soluble organic bases, e.g. 4-cyanopyridine titrated in D₂O with an internal standard: tetramethylammonium chloride. Pmr shift vs. pH gives titration curve.

***PHYS DENSITY PHASE REFRACT SURFACE VISC 3**

A Laboratory Study of Liquid Pairs
Hanson, A. L.
J. Chem. Educ. 37,143 (1960)
Pedagogical. 2 miscible unknowns issued. Variety of properties of mixtures measured. Caution: avoid liquids now known to be carcinogens, eg., chloroform, carbon tetrachloride.

***PHYS CLOCK KIN 2**

"Scientific Method" Through Laboratory Experience
Hanson, A. L.
J. Chem. Educ. 58,434 (1981)
A stepwise approach to investigate the nature of the iodine clock reaction, with much detail and direction to the student. The first investigation should specify reagent concentrations.

***PHYS APPARATUS SURFACE VACTEK 3 HAZARD**

Adsorption of Benzene on Silica Gel: A High Vacuum Experiment
Hanson, J. C.; Stafford, F. E.
J. Chem. Educ. 42,88 (1965)
Adsorption isotherm. Schematic vac. manifold to use no grease or o-rings.
HAZARD: (1) benzene (sample), (2) CHCl₃, CCl₄ in the freezing mixture. Carcinogens. Avoidable.

***PHYS DENSITY GAS 0 1 2**

The Density and Apparent Molecular Weight of Air
A Simple Introductory Experiment
Harris, A. D.
J. Chem. Educ. 61,74 (1984)
Uses simple apparatus made from common lab hardware to find the apparent molecular weight of air by measurement of the mass of a fixed volume at two different temperatures. The derivation of the requisite equations is shown; results are within 5% of accepted value.

***PHYS COLLIG GAS VAPORPRESS 2 HAZARD**

A Raoult's Law Experiment For The General Chemistry Course: Manometry Without a Manometer
Harris, F. E.; Nash, L. K.
J. Chem. Educ. 32,575 (1958)
Simple setup. No special apparatus. Vapor pressures of two miscible, water-insoluble liquids determined by change of pressure of air trapped over water. HAZARD: benzene (avoidable).

***PHYS GAS STATISTICS THERMO UVIS VAPORPRESS 4**

Standard Entropy of Crystalline Iodine From Vapor Pressure Measurements:
A physical chemistry experiment
Harris, R. M.
J. Chem. Educ. 55,745 (1978)
Thermostatted cell required. Measure vapor pressure spectroscopically.

***PHYS COMPUTER COURSE NOPROC XRAY 4**

From Molecular Point Group Symmetry to Space Group Symmetry: An undergraduate experiment in model building
Hathaway, B.

J. Chem. Educ. 56,166 (1979)

Student provided an x-ray structure paper, to build model of one asymmetric unit in unit cell, then generates coordinates and computer plot. Three year time-table for teaching molecular symmetry and crystallography at the undergraduate level given.

***PHYS GAS 1**

Charles' Law: A general chemistry experiment
Haworth, D. T.

J. Chem. Educ. 44,353 (1967)

No special apparatus.

***PHYS DEMO PHASE 2**

A Thermal Analysis Experiment for Introductory Chemistry

Haworth, D. T.; McGrath, J. D.

J. Chem. Educ. 41,372 (1964)

Tin-lead eutectic phase diagram. Caution - danger with molten metals (350 deg. C). RPI uses it as a demo (thermocouples, chart recorder, closed circuit TV).

***PHYS ANAL IONX KSP TITN 2**

A New Twist to Ksp Evaluation

Hazel, J. F.

J. Chem. Educ. 43,636 (1966)

Saturated solution of slightly soluble salt thru cation exchange resin, titrate acid in effluent. Caution: Pb is an embryotoxin. See Koubek, E., J. CHEM. EDUC., 53, 254 (1976) for an additional Ksp determination and a contrast with solubility.

***PHYS APPARATUS KIN TECHNIQUE UVIS 3**

Hydration of Aldehydes: A Temperature-Jump Relaxation Experiment For Physical Chemistry

Heck, H.; Iwata, A.; Mah, F.

J. Chem. Educ. 50,141 (1973)

Requires recording spectrophotometer, special apparatus. Data for propanal/50% aq. diglyme given. Suggested questions.

***PHYS COORD EDTA KIN UVIS 2 3**

Formation of The Chromium-EDTA Complex: An undergraduate kinetics experiment

Hedrick, C. E.

J. Chem. Educ. 42,479 (1965)

Rate of formation of Cr(III)-EDTA complex is followed with a Spec-20, det'nd at various pH values, excess EDTA, to get reaction order in chromium(III) and hydrogen ion. See also Agger, Sr. R.M.; L.H.M.; Hedrick, C.E., J. CHEM. EDUC., 43, 541 (1966). "The Effect of Carbonate on the Chromium(III)-EDTA Reaction" for a corollary.

***PHYS ANAL ACBA COMPUTER DRYLAB PH 3**

Computer Simulation of Acid-Base Behavior

Hefter, J.; Zuehlke, R. W.

J. Chem. Educ. 54,63 (1977)

Simulates color of methyl red vs. pH. Program available in FORTRAN and in BASIC.

***PHYS COURSE ELECTROCHEM KEQ MOLTENSALT PAPERC REDOX 1**

General Chemistry Experiments: Six short inexpensive procedures

Heit, M. L.; Dauphinee, G. A.

J. Chem. Educ. 47,532 (1970)

Readily available reagents used for experiments designed to be striking and to illustrate some physical concepts: molten salt conductivity, paper chromatography, sublimation, redox, equilibrium.

***PHYS IR MOL.SPECT QUANTUM 4**

Infrared Emission Spectrum of the Hydroxyl Radical: A Novel Experiment in Molecular Spectroscopy

Henderson, G.; Ko, C-S.; Huang, T-C.

J. Chem. Educ. 59,683 (1982)

Parameters derived from an ab initio potential are used to calculate vibrational-rotational energy levels and then construct a stick spectrum for the overtone emissions of the hydroxyl radical. Students then use their results to design an experiment to observe the spectra in the lab using an oxy-acetylene torch as a source.

***PHYS ORD 4**

Optical Rotary Dispersion in Transparent Media

Henderson, G. L.

J. Chem. Educ. 45,515 (1968)

D-camphor in solution, sodium chlorate in solid. Theory in some detail.

***PHYS APPARATUS DEMO ELECTROCHEM PH PROJ 2**

Demonstration of Electrochemical Cell Properties by a Simple, Colorful Oxidation-reduction Experiment

Hendricks, L. J.; Williams, J. T.
J. Chem. Educ. 59, 586 (1982)

Indicators undergo color change at electrodes, simply constructed apparatus, possible student project.

***PHYS AVOGADRO GAS MICROSCOPE 3**

Evaluation of Avogadro's Number: A general chemistry experiment
Henry, P. S.

J. Chem. Educ. 43, 251 (1966)

Perrin's method. Det'n Boltzmann constant, K, from distribution of particles in suspension. Uses latex spherules, 300x microscope, eccentric pinhole, water, ethanol. Designed for G. Chem., but math would intimidate most freshmen. Refer Slabaugh, W.H., J. Chem. Educ. 42, 471 (1965).

***PHYS PHASE 3 HAZARD**

Tie Line Correlation and Plait Point Determination
Heric, E. L.

J. Chem. Educ. 37, 144 (1960)

HOAc-H₂O-benzene. Students follow exp't in standard phys. chem. lab. text, find the lines. Phase diagram given. HAZARD: benzene, carcinogen.

***PHYS PHASE 3**

A Phase Rule Experiment: The System Lead Nitrate-Sodium Nitrate-Water
Heric, E. L.

J. Chem. Educ. 35, 510 (1958)

Straightforward. The triangular diagram is given. Analysis is by the wet residue method of Schreinemakers.

***PHYS GAS 1 2 HAZARD**

Boyle's Law Experiment

Hermens, R. A.

J. Chem. Educ. 60, 764 (1983)

A novel method of measuring volume change with pressure of air trapped in a capillary by a short column of mercury. The position of the capillary is changed from vertical to a fixed angle to inverted.

HAZARD: mercury

***PHYS APPARATUS CALORIMETRY ELECTROANAL THERMO 3**

Heat of Reaction in Aqueous Solution by Potentiometry and Calorimetry:

1. A Metal Displacement Reaction

Hill, D. L.; Moss, S. J.; Strong, R. L.

J. Chem. Educ. 42, 541 (1965)

Sophisticated equipment. Requires special cell (design given), high-grade potentiometer, temp.-controlled, solution calorimeter. $Zn + 2Ag(+) = Zn(++) + 2Ag$.

***PHYS CONDUCT ELECTROCHEM SAFETY 3**

Acetic Acid in Toluene: A safer conductivity experiment

Hill, J. W.

J. Chem. Educ. 53, 779 (1976)

Acetic acid/toluene is a safe substitute for the older (benzene/ HCl) mixture in electrical conductivity experiments.

***PHYS COMPUTER GAS KIN STATISTICS 4**

Modeling of Molecular Velocity Distributions: A physical chemistry experiment

Hinds, D.; Parrish, D. D.; Wartell, M. A.

J. Chem. Educ. 55, 670 (1978)

Kinetic theory experiment uses computer-modelled two dimensional gas collisions to develop Boltzmann distribution. Statistical data analysis. Article states that program is available by writing but we got no response.

***PHYS CRYO TECHNIQUE 3**

Freezing Point Measurement

Hoare, J. P.

J. Chem. Educ. 37, 146 (1960)

Not a student experiment. Uses differential thermometer, mechanical stirring. FP obtained by deliberate supercooling, extrapolation (2 ways) back to freezing point. But one should use this not to repeat it, but to modify freezing point measurement techniques.

***PHYS INORG NMR PREP VACTEK 4**

A Change in the Sign of an NMR Coupling Constant: An advanced undergraduate experiment

Hoff, J. L.; Furtch, T. A.; Mills, J. L.

J. Chem. Educ. 56, 125 (1978)

Demonstrates change in sign of P-C-H coupling constant 2J(P-H) between trivalent and tetravalent phosphorous. Proton nmr. Caution: trimethylborane and trimethylphosphine are pyrophoric and toxic.

***PHYS IR MOL.SPECT QUANTUM 4**

Pure Rotation Spectra of HCl and NH₃: A physical chemistry experiment
Hollenberg, J. L.
J. Chem. Educ. 43,7 (1966)
Spectra given. Gas cell.

***PHYS HISTORIC MOL.SPECT QUANTUM 2**

The Spectrum of Atomic Hydrogen
Hollenberg, J. L.
J. Chem. Educ. 43,216 (1966)
High voltage discharge tube, Beckman DU. Intensity measured.

***PHYS GAS 1**

The Variation of the Mass of a Gas With Its Pressure
Hopkins, D. E.
J. Chem. Educ. 53,718 (1976)
Home made gas container from aerosol can; vac pump, tire pressure gauge, foot or hand pump. Permits calc. of atmospheric pressure and R (gas constant).

***PHYS ORG KIN NMR 3**

Determination of the Rate of Solvolysis of Benzhydryl Bromide: An nmr experiment
Horman, I.; Strauss, M. J.
J. Chem. Educ. 46,114 (1969)
Aqueous-dioxane solvolysis. H⁺ conc. measured by shift of nmr absorption with time.

***PHYS DRYLAB MOL.SPECT RAMAN 4**

Pure Rotational Raman Spectroscopy: A Dry-Lab Experiment
Hoskins, L. C.
J. Chem. Educ. 54,642 (1977)
Explicit directions for student analysis of Raman spectra of hydrogen and carbon dioxide, and determination of bond distances.

***PHYS MOL.SPECT RAMAN 4**

Pure Rotational Raman Spectroscopy of Diatomic Molecules
Hoskins, L. C.
J. Chem. Educ. 52,568 (1975)
Laser Raman for rotational spectra of nitrogen and oxygen. Discusses theory.

***PHYS MOL.SPECT RAMAN TLC UVIS 3 4**

Resonance Raman Spectroscopy of beta-Carotene and Lycopene
A Physical Chemistry Experiment
Hoskins, L. C.
J. Chem. Educ. 61,460 (1984)
Lycopene and beta-carotene, prepared from tomato paste and carrot root and purified by TLC, are used in resonance Raman and visible spectrum studies. Requires an argon laser. CAUTION: benzene is used as a solvent for TLC.

***PHYS INORG APPARATUS COORD DEMO MAGNETIC SOLID 4**

A Simple Demonstration of the Curie-Weiss Law and a Spin-Crossover Compound
Hutchinson, B.; Hance, R. L.; Hardegree, E. L.; Russell, S. A.
J. Chem. Educ. 57,830 (1980)
Magnetic susceptibility measured with "inexpensive" apparatus (J. CHEM. EDUC., 56, 170 (1979)) modified to control temp. Extension of earlier work; have temp varied to show Curie-Weiss law and d-electron arrangements. Preparation of suitable compounds referenced. Three hours; can be a demonstration.

***PHYS CATAL HITEMP KEQ 4**

Determining the K_p for the Ammonia Synthesis as a Function of Temperature
Huybrechts, G.; Petre, G.
J. Chem. Educ. 53,443 (1976)
K_p from 820 to 1018 deg. K and 1 atm. pressure. Furnace, apparatus described. Flow rates and concentrations of ammonia are measured.

***PHYS DENSITY PHASE 3**

A Simple Method for the Determination of a Liquid-Vapor Equilibrium Curve
Idoux, J. P.
J. Chem. Educ. 46,532 (1969)
Vapor and liquid samples (methanol-water) obtained by distillation. Composition measured by density variation. (Archimedeian method). Within capacity of many freshmen.

***PHYS PROJ VISC 3**

Viscosities of Butanol-Heptane Mixtures
Innes, K. K.
J. Chem. Educ. 38,564 (1961)
A problem posed to students to extend existing viscosity measurements of liquid mixtures to larger temperature ranges and determine relationship to simplest temp. visc. equation. Ostwald viscometer.

***PHYS DIFFUSION UVIS 3 4**

A Spectrophotometric Method for Measuring Diffusion Coefficients

Irina, J.

J. Chem. Educ. 57,676 (1980)

Diffusion coefficients of KNO_3 , AgNO_3 , LiNO_3 , $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ in aqueous sol'n determined by dropping crystal into spectrophotometer cell and measuring absorbance as function of time and distance from bottom of cell. Measurements require 6-40 hrs.

***PHYS INORG COORD UVIS 3 4**

Base-Catalyzed Linkage Isomerization: An undergraduate inorganic kinetics experiment.

Jackson, W. G.; Lawrance, G. A.; Lay, P. A.; Sargeson, A. M.

J. Chem. Educ. 58,734 (1981)

Rearrangement of nitrito to nitro cobalt (III) ammine complex.

***PHYS CLATH COORD CRYSTAL DENSITY PREP PROJ XRAY 4 HAZARD**

A Physical Chemistry Experiment on Clathrates

Jacobs, G. D.

J. Chem. Educ. 47,394 (1970)

$\text{Ni}(\text{CN})_2 \cdot \text{NH}_3 \cdot 6\text{H}_2\text{O}$ is prepared. X-ray powder spectrum, flotation method (for density). HAZARDS: cyanides are highly toxic; benzene and chloroform are carcinogens.

***PHYS DIPOLE REFRACT 3 HAZARD**

Determination of the Dipole Moment of Polar Compounds in Nonpolar Solvents

Janini, G. M.; Katrib, A. H.

J. Chem. Educ. 60,1087(1983)

Exptl detn of dipole moments of isomeric compounds p-methoxybenzylidene-p-cyanoaniline and p-cyanobenzylidene-p-methoxyaniline, mthd based on that of Guggenheim & Smith. One lab period. Requires dipole meter & refractometer.

Hazard: benzene. (Other solvents used: n-hexane, cyclohexane, toluene)

***PHYS ORG ACBA KIN 4**

Hydrolysis of Ethyl Acetate in Concentrated Sulfuric Acid: A group experiment for advanced students

Jaques, D.

J. Chem. Educ. 48,623 (1971)

Requires 10-12 hours continuous monitoring. Method based on quant. conversion of the ester to its hydroxamic acid, which is det'ned colorimetrically by its ferric chloride complex. Uses Hammett acidity function; reaction mechanism det'n. Study questions.

***PHYS KIN REDOX UVIS 2 3**

Oxidation of Benzoin by Hexacyanoferrate(III): An advanced kinetic experiment

Jarrar, A. A.; El-Zaru, R.

J. Chem. Educ. 54,326 (1977)

Followed spectrophotometrically (visible). First order in benzoin, ferricyanide, hydroxide. Within capacity of most freshmen.

***PHYS ACBA ELECTROANAL KEQ KSP NOPROC 4**

Estimation of Some Ionization and Solubility Product Constants by Potentiometric Titration

Jenkins, D. A.; Latham, J. L.

J. Chem. Educ. 43,82 (1966)

Research report, not a student experiment. Gives equations for calculation of ionization constants, etc., from the data and results of pot. titration of a variety of Bronsted acids with NaOH , AgOH . Equations given could be used for a more sophisticated treatment of student data.

***PHYS ACBA COMPUTER TITN 3**

Determination of Successive Ionization Constants: A computer assisted laboratory experiment

Jensen, R. E.; Garvey, R. G.; Paulson, B. A.

J. Chem. Educ. 47,147 (1970)

Titration of base or acid; data into computer program to calculate K_1 and K_2 .

***PHYS ANAL PHASE REDOX SOLID SOLUB 4 5**

Preparation and Analysis of Solid Solutions in Potassium

Perchlorate-Permanganate System

Johnson, G. K.

J. Chem. Educ. 56,618 (1979)

Several samples in the nearly ideal solid solution series $\text{K}(\text{MnO}_4-\text{ClO}_4)$ are prepared and analyzed by redox titration of the permanganate ion. A simple theoretical treatment based upon aqueous solubility equilibria is applied. Designed for seniors and graduate students in inorganic chem. Detailed.

***PHYS CRYO CRYO CRYSTAL QUANTUM UVIS 4**

Polarized Electronic Absorption Spectrum at 300K and 77K: A physical chemistry laboratory experiment

Johnson, L. W.; Wong, K.

J. Chem. Educ. 56,275 (1979)

$(\text{LiMnO}_4 \cdot 3\text{H}_2\text{O}-\text{LiClO}_4 \cdot 3\text{H}_2\text{O})$ crystal prep'n. Recording spectrometer. Can be done at 300K; better at 77K. Designed to illustrate polarization properties of the electronic transition moment.

***PHYS APPARATUS ELECTROCHEM THERMO 3**

Laboratory Experiment Concerning the Gibbs-Helmholtz Relationship
Johnson, R. S.; Crawford, D. E.
J. Chem. Educ. 46, 52 (1969)
Temp. coefficient of E for a lead - lead dioxide cell in a thermostat.
Cell constructed from lead sheet and storage battery positive plate.

***PHYS ANAL ORG GC KIN 3**

The Methanolysis of Acetal: A chemical kinetics and gas chromatography experiment
Johnston, D. O.
J. Chem. Educ. 44, 33 (1967)
Catalysed consecutive reactions, first order, plus steady state hypothesis.
Typical chromatogram and method of data treatment given. Has worked well here.

***PHYS APPARATUS GAS KEQ THERMO 3**

The Thermodynamic Properties of Ammonium Carbamate: An experiment in heterogeneous equilibrium
Joncich, M. J.; Solka, B. H.; Bower, J. E.
J. Chem. Educ. 44, 598 (1967)
Details of apparatus assembly given. Decomp. of ammonium carbamate in the range 30-50 deg. Celsius, followed by pressure change gives free energy, entropy, and enthalpy for process.

***PHYS ANAL BIOCHEM COMPUTER ENZYME KIN 3 4**

On-Line Digital Computer Applications to Kinetic Analysis
Jones, D. O.; Scamuffa, M. D.; Portnoff, L. S.; Perone, S. P.
J. Chem. Educ. 49, 717 (1972)
Laboratory computer system measures time for specific fraction of reaction. Applied to glucose oxidase catalyzed glucose oxidation; hydrogen peroxide produced oxidizes iodide, rotating platinum electrode measures iodide concentration. Extensions.

***PHYS ORG ISOTOPE KIN UVIS 4**

Kinetic Isotope Effects: An experiment in physical organic chemistry
Jones, J. R.
J. Chem. Educ. 44, 31 (1967)
Comparison of rates of reaction of acetone and deuterated acetone with hypobromite solution, followed colorimetrically. (330nm).

***PHYS ANAL ACBA CLOCK DEMO ENZYME KIN 3**

The Hydration of Carbon Dioxide: A Double Clock Experiment
Jones, P.; Haggett, M. L.; Longridge, J. L.
J. Chem. Educ. 41, 610 (1964)
Can be used as a simple demo, a more elaborate two indicator demo, or as a student experiment in kinetics. Simple equipment. $\text{CO}_2(\text{aq}) + \text{NaOH}$. Suggest Americans try Club soda as CO_2 source. Catalysis by carbonic anhydrase (blood) and by formalin can be demonstrated. Caution: blood can be an infection hazard.

***PHYS CALORIMETRY THERMO 2**

A Laboratory Experiment Yielding Entropy Changes
Jordan, A. D.; Kalantar, A. H.
J. Chem. Educ. 55, 183 (1978)
Entropy change on mixing water at two different temperatures is calculated. Very simple apparatus. Suitable for larger classes.

***PHYS COMPUTER KEQ KIN UVIS 2 3**

Utilization of a Microcomputer for the Study of an Iodide Oxidation and Equilibrium Reaction; A Physical Chemistry Experiment
Julien, L. M.
J. Chem. Educ. 61, 826 (1984)
The reaction of iodide with persulfate ions is studied. A microcomputer is used to predict exptl. conditions, i.e., concentrations which will give measurable absorbance. Microcomputer analysis of exptl. data gives rate constant and reaction order of individual reactants.

***PHYS ANAL ELECTROANAL MISTAKE 4 HAZARD**

Potentiometric Determination of the "Operational" K_{sp} of AgI
Jurio, R. L.; Ungerer, B.; Manuele, R. J.
J. Chem. Educ. 48, 122 (1971)
Precision work. The titration cell is $\text{Hg}/\text{Hg}_2\text{Cl}_2(\text{s}), \text{KCl}(\text{sat'd})//\text{KI}(\text{aq.})$
 $\text{AgI}(\text{s})/\text{Ag}$; emf msmnts as Ag^+ added dropwise to Ag half-cell. $K_{sp}(\text{AgI})$, Ag^+ activity calculated. HAZARD: cyanides, can be avoided. (The mistake is in the title of the article.)

***PHYS ANAL DISTRIB KEQ TITN 2 3**

A Graphical Procedure for the Simultaneous Determination of the Distribution Constant of Iodine and the Stability Constants of Trihalide Anions
Kahwa, I. A.
J. Chem. Educ. 61, 823 (1984)
A graphical method is used to find the water/organic solvent distribution constant and the stability constant of trihalide ions. Iodine concentrations are found by standard iodometric methods.

*PHYS DENSITY GAS 1

A Simple Molecular Weight Experiment

Kalbus, L.; Petrucci, R. H.

J. Chem. Educ. 48, 107 (1971)

Dumas method. Weigh a balloon-full of CO₂ (dry ice), volume by displacement of water.

*PHYS ANAL INORG APPARATUS COORD PHOTO PREP PROJ 2

Investigation of the Photochemistry of Oxalatobisethylenediaminecobalt(III)

Ion: A freshman class project

Kantrowitz, E. R.

J. Chem. Educ. 51, 202 (1974)

Requires gas analysis train. Open-ended. Explicit directions for preparation of complex compound. Photolysis cell described. Project includes pH, uvis, kin, ionx, etc.

*PHYS INORG APPARATUS HITEMP SOLID VACTEK 4 5

Hydrogen in Zirconium: An experiment in chemical equilibria

Katz, O. M.; Gulbransen, E. A.

J. Chem. Educ. 37, 533 (1960)

Solid-gas equilibria. Furnace to 800 deg. C on vac. system capable of 10(-6) torr (zirconium getter) required. Caution: H₂ at 400 deg.

*PHYS ORG KIN NMR PREP 3

An NMR Kinetics Experiment

Kaufman, D.; Sterner, C.; Masek, B.; Svenningsen, R.; Samuelson, G.

J. Chem. Educ. 59, 885 (1982)

Acid-catalyzed hydration of p-methoxyphenylacetylene (new synthesis method outlined) to ketone followed by observing change in relative sizes of methoxyl peaks (D₂O). Runs conducted at 30 and 40 deg. C. (thermostatted bath) allow calc. of energy of activation.

*PHYS GAS NOPROC VAPORPRESS 2

Molecular Weights from Dumas Bulb Experiments

Kaya, J. J.; Campbell, J. A.

J. Chem. Educ. 44, 394 (1967)

Improved student determinations by giving data to estimate optimum conditions for experiment. No procedure, but specific thought-provoking questions allow student to develop one for (his/her) self.

*PHYS APPARATUS SURFACE 3

A Simple, Surface and Interfacial Tension Experiment

Kay, M.; McClure, D. W.

J. Chem. Educ. 47, 540 (1970)

Double capillary technique used to measure liquid-air and liq.-liq. interfacial tension. Simple apparatus but must be very clean. Traveling microscope or cathetometer.

*PHYS GC 4 HAZARD

Determining Activity Coefficients by Gas Chromatography: A physical chemistry experiment

Kenworthy, S.; Miller, J.; Martire, D. E.

J. Chem. Educ. 40, 541 (1963)

Measure retention vol. of benzene and of cyclohexene on dinonyl phthalate column. HAZARD: benzene is a known carcinogen.

*PHYS APPARATUS MASSPEC THERMO 3

The Latent Heat of Vaporization of an Organic Solid: An undergraduate experiment

Khouw, B. H.; Pritchard, H. O.

J. Chem. Educ. 52, 730 (1975)

Measurement of heat of vaporization by following line width of mass spectrum of sat'd vapor in He gas carrier over T-range 90-115 deg. C. Data given for benzoic acid.

*PHYS DEMO SOLAR THERMO 0

Solar Energy Storage: A Demonstration Experiment

Kimmel, H. S.; Tomkins, R. P. T.

J. Chem. Educ. 56, 615 (1979)

CoCl₂·6H₂O is pink in aq. 2-propanol at room temp., blue when heated by warm water. Reaction is readily reversed upon cooling.

*PHYS APPARATUS ELECTROANAL SURFACE TECHNIQUE 4

The Streaming Potential Electrode: A senior undergraduate electrochemistry experiment

Kimmerle, F. M.; Menard, H.

J. Chem. Educ. 51, 808 (1974)

Polarography. Special cell, construction details given. High impedance potentiometer required. Intent of exp't is to measure ionic and molecular adsorption at electrified interface.

***PHYS AVOGADRO SURFACE 2**

Estimation of Avogadro's Number:

An experiment for general chemistry laboratory

King, L. C. C.; Neilsen, E. K. K.

J. Chem. Educ. 35, 198 (1958)

First description of a much-used experiment. Measures area and weight of an oleic acid film on water. For later suggestions, see Lane, C. A., Burton, D. E., and Crabb, C. C., J. Chem. Ed., 61, 815 (1984).

***PHYS ACTIVITY KEQ KIN UVIS 3 4**

The Kinetics and Mechanism of the Decomposition of Murexide in Acid Solution

An Experiment for Teaching Principles of Chemical Kinetics

Knoche, W.; Rees, N. H.

J. Chem. Educ. 61, 724 (1984)

Decomposition of murexide in acid aqueous solution and in the presence of metal ions studied with spectrophotometer. Measurements at low pH require simple stopped flow apparatus. The rate constant, the association constant of purpuric acid, and the stability constant of murexide/metal ion complexes are evaluated.

***PHYS BIOCHEM CRYSTAL DENSITY XRAY 4**

Protein Molecular Weight by X-ray Diffraction

Knox, J. R.

J. Chem. Educ. 49, 476 (1972)

Technique of growing good protein crystals for X-ray analysis and X-ray photography with a precession camera, two exposure. Density is by density gradient column. Much time for crystal growth and X-ray.

***PHYS ANAL AVOGADRO COURSE GRAVIM RADIOCHEM 2 HAZARD**

Cloud Chamber, Molecular Film, and Atomic Weight of Silver: Experiments for general chemistry 1

Kokes, R. J.; Dorfman, M. K.; Mathia, T.

J. Chem. Educ. 39, 18 (1962)

Describes first three exp'ts Johns Hopkins, Gen. Chem. Simply constructed cloud chamber, radioactive source. Avogadro number by stearic acid monolayer, Ag gravimetrically by chloride. HAZARD: benzene, carcinogen, Stony Brook uses hexane as solvent for this experiment. For suggestions on stearic acid monolayer expt., see Lane, C. A., Burton, D. E., and Crabb, C. C., J. Chem. Educ., 61, 815 (1984).

***PHYS COURSE GAS NOPROC PHASE VACTEK 2**

A Simple Vacuum System: Experiments for general chemistry II

Kokes, R. J.; Dorfman, M. K.; Mathia, T.

J. Chem. Educ. 39, 20 (1962)

Design of system, general descript. of experiments on Boyle's Law, molecular weight determination, vapor pressure measurement.

***PHYS CALORIMETRY COURSE THERMO 2**

Calorimetry: Experiments for General Chemistry III

Kokes, R. J.; Dorfman, M. K.; Mathia, T.

J. Chem. Educ. 39, 90 (1962)

Heat capacity of nickel or copper, heat of neutralization measured in jacketed student calorimeter (inexpensive).

***PHYS CATAL COURSE KEQ VACTEK 2 HAZARD**

Chemical Equilibrium - The Hydrogenation of Benzene: Experiments for general chemistry IV

Kokes, R. J.; Dorfman, M. K.; Mathia, T.

J. Chem. Educ. 39, 91 (1962)

Using simple vacuum system, nickel catalyst activated at 270 deg. C. with H₂, benzene-hydrogen-cyclohexane equilib. is studied at three to four temperatures. Hazard: benzene is a carcinogen, catalyst is pyrophoric, hydrogen is an explosive hazard.

***PHYS ANAL COURSE KEQ SOLUB 2**

Equilibria in Ionic Solutions: Experiments for general chemistry V

Kokes, R. J.; Dorfman, M. K.; Mathia, T.

J. Chem. Educ. 39, 93 (1962)

Two to three period study of K_a for chloroacetic acid and K_{sp} for silver chloroacetate. Latter by silver analysis; former by variation in the solubility of silver salt with pH.

***PHYS GLASS SOLID 2 3**

Demonstration of the Glass Transition

Koleske, J. V.; Faucher, J. A.

J. Chem. Educ. 43, 254 (1966)

Glucose pentaacetate (alpha-D- or beta-D-) forms glass on quick cooling. Hand working to raise temp. (or torsion pendulum to measure effect at different temp.) gives transition to rubbery solid (glass transition temp. 30 deg C.) and then to crystalline powder (cryst. temp. 45-50 deg C.) and finally to melt, 132 deg C. Shear modulus also calc'd.

***PHYS COMPUTER DRYLAB FASTREACTION 4**

HO₂ Kinetics in Simple Systems. An Introductory Problem in Computer Simulation.

Koop, S. M.; Ogren, P. J.

J. Chem. Educ. 53,128 (1976)

System studied is the flash photolysis of water vapor in the presence of a small amount of O₂ and an atmosphere of He or Ar at 25 deg. Celsius. Given the rate constant (taken from literature, not measured) students are asked to determine the conc. of perhydroxy radical as a function of time. Simulation involves rate constants for nine related equations.

***PHYS APPARATUS DEMO VAPORPRESS 2**

A Simple Apparatus Designed to Measure Vapor Pressures and Demonstrate the Principles of Raoult's Law

Koubek, E.; Paulson, D. R.

J. Chem. Educ. 60,1069(1983)

Simple apparatus design described for msmt of vapor pressure of common organic solvents. CAUTION: avoid benzene (toxic hazard).

***PHYS ANAL COMPUTER DRYLAB TITN 3**

Location of the Equivalence Point in Potentiometric Titrations:

A simulated laboratory exercise

Kozarek, W. J.; Fernando, Q.

J. Chem. Educ. 49,202 (1972)

Gran's method (extrapolation of plots of volumes of added base give H⁺ conc. vs. volume of added base) in computer simulated titrations.

***PHYS ORG KIN PHOTO PREP UVIS 4**

The Photochemical Synthesis, Kinetics and Reactions of Nitrosomethane

Dimer: A Physical-Organic Experiment

Kozubek, H.; Marciniak, B.; Paszyc, S.

J. Chem. Educ. 59,889 (1982)

Photochemical preparation from t-butyl nitrite (prep. by reference).

Diagram of immersion reactor given. The rates of decay by isomerization and by decomposition of the dimer in ethanolic solution under UV irradiation are followed by absorption at two wavelengths in the UV. No discussion of reactions.

***PHYS FLASHPHOTOL KIN UVIS 3**

Kinetics of Reactions of Monomeric Nitrosomethane Induced by Flash Photolysis

Kozubek, H.; Marciniak, B.; Paszyc, S.

J. Chem. Educ. 61,835 (1984)

A modified UV-VIS spectrophotometer is used to study the kinetics of nitrosomethane dimer formation from monomer (not a photochemical reaction). The monomer is formed from dimer (prepared by ref. to J. Chem. Ed.) by a 2 sec. flash at 290nm. Uranyl oxalate actinometry to get quantum yield. The enthalpy, entropy, and rate constants as a function of temp. are obtained.

***PHYS ORG DEMO PREP PROJ SURFACE 2 3**

Long-Lived Soap Bubbles: The Use of Sodium 9,10-Dibromostearate Solutions

Kuehner, A. L.

J. Chem. Educ. 35,337 (1958)

Not described as an experiment, but very suitable for student projects.

Prep. of surfactant from oleic acid.

***PHYS DRYLAB NMR QUANTUM 4**

An NMR Laboratory-Problem for Introductory Quantum Chemistry

Kuhlmann, K. F.; Braun, C. L.

J. Chem. Educ. 46,750 (1969)

Using prerecorded or their own nmr spectra, students analyze an AB spectrum. Most emphasis on development of theoretical understanding of the complex equations using quantum theory.

***PHYS PHASE 3 HAZARD**

Binary Heterogeneous Vapor-Liquid Equilibrium: A physical chemistry experiment

Kurtyka, Z. M.

J. Chem. Educ. 54,389 (1977)

Distillation of immiscible and partly miscible two component systems.

Antoine equation. Common lab solvents and water. HAZARD: avoid benzene - a known carcinogen.

***PHYS APPARATUS DIPOLE 3**

A New Simple Apparatus for the Measurement of Dipole Moments

Kurtz, S. R.; Anderson, O. T.; Willeford, B. R., Jr.

J. Chem. Educ. 54,181 (1977)

Construction details; simple electronics. Requires frequency counter.

***PHYS COMPUTER FLUOR QUANTUM UVIS 4**

Vibronic Analysis of the Visible Absorption and Fluorescence Spectra of the Fluorescein Dianion
Kurucsev, T.

J. Chem. Educ. 55,128 (1978)

Visible (400-530 nm) and fluorescence (490-600 nm) spectra measured and analyzed.

***PHYS APPARATUS FLUOR VACTEK 3 4**

The Role of Collisions in the Fate of Excited States; A Simple Experiment
Lain, L.; Torre, A.

J. Chem. Educ. 61,636 (1984)

The fluorescence of I2 is studied in the presence and absence of inert gases. The quenching efficiency, due to inelastic collisions with inert gas molecules is measured. The experiment is simple but requires suitable apparatus.

***PHYS ACBA COMPUTER KEQ KIN PH 4**

Determination of pKa of Phenolphthalein and its Discoloration Rate
Lalanne, J. R.

J. Chem. Educ. 48,266 (1971)

Developed for sec. school teachers. All equipment should be available, better schools. 4 equilibria. Results from many experiments computer averaged.

***PHYS APPARATUS ELECTROOPTIC LIQUID.CRYSTAL PHASE UVIS 4**

Three Liquid-Crystal Teaching Experiments

Lalanne, J. R.; Hare, F.

J. Chem. Educ. 53,793 (1976)

Cells from transparent conducting plates, various liquid crystals and mixtures. Measure absorption spectra with and without field. Variation of transmission with voltage.

***PHYS ANAL ASSOC BIOCHEM COMPLEX DIFFUSION MEMBRANE PHASE 3 4**

Experimenting with Liquid Membranes

Lamb, J. D.; Cristensen, J. J.; Izatt, R. M.

J. Chem. Educ. 57,227 (1980)

Simple apparatus for demonstrating both active and passive transport of metal salts across liquid membranes. Major focus is on transport between two aqueous phases across chloroform phase in which dibenzo-18-crown-6-ether serves as carrier. Caution: CHCl₃ is suspected carcinogen. Crown ethers are toxic and irritants.

***PHYS SURFACE 2 3**

Accurate Molecular Dimensions from Stearic Acid Monolayers

Lane, C. A.; Burton, D. E.; Crabb, C. C.

J. Chem. Educ. 61,815 (1984)

Simple modifications, including recrystallization of stearic acid, of previously described experiment give accurate molecular cross sectional area and length.

***PHYS ORG EXCHANGE ISOTOPE KIN NMR 3**

An NMR Demonstration of Isotopic Exchange

Lapidot, A.; Reuben, J.; Samuel, D.

J. Chem. Educ. 41,570 (1964)

Hydroacrylonitrile undergoes deuterium exchange with a D₂O-NaOH mixture, analysis by NMR. Integration of peak intensities leads to rate constant.

***PHYS COMPUTER KIN 3**

Process Dynamics Experiment

Larson, M. A.; Heng, O. A.

J. Chem. Educ. 39,29 (1962)

Chemical engineering process dynamics measured and simulated on analog computer.

***PHYS PHASE THERMO 2**

Freezing Curves for Salol

Laswick, P. H.

J. Chem. Educ. 49,537 (1972)

Simple cooling curves. Salol gives much supercooling, forms beautiful crystals. Salol is phenyl salicylate.

***PHYS LASER 4**

Laser Experiments in Undergraduate Physical Chemistry Laboratory

Layton, R. G.; Eyring, E. M.

J. Chem. Educ. 40,338 (1963)

Early article giving method for measure of wavelength and energy (thermistor, Wheatstone bridge), and suggesting possible applications in experiments.

***PHYS ISOTOPE MASSPEC NOPROC 3**

Relative Isotopic Abundances in Halogenated Methane Fragments: An undergraduate experiment

Leech, J. R.; Daugherty, K. E.

J. Chem. Educ. 50, 569 (1973)

CCl₄, CHCl₃, CH₂Cl₂, CBrCl₃, CH₃I. Caution: chloroform and carbon tetrachloride are carcinogens, but could be handled safely for masspec. work.

***PHYS CLOCK KIN OSC.RXN 2**

The Color Blind Traffic Light: An undergraduate kinetics experiment using an oscillating reaction

Lefelhocz, J. F.

J. Chem. Educ. 49, 312 (1972)

Ceric ammonium sulfate, KBrO₃, malonic acid, ferroin, H₂SO₄.

Concentration, temp., and pH varied. See also Boulanger, M.M., J.

CHEM. EDUC., 55, 584 (1978).

***PHYS FLUOR KIN UVIS 3 HAZARD**

The Rate Constant For Fluorescence Quenching: An undergraduate experiment using the spectronic 20

Legenza, M. W.; Marzzacco, C. J.

J. Chem. Educ. 54, 183 (1977)

Anthracene fluorescence quenching by CCl₄. Stern-Volmer mechanism.

HAZARD: CCl₄, carcinogen.

***PHYS GRAVIM NOPROC QUANTUM 2**

The Planck Radiation Law and the Efficiency of a Light Bulb

Lehman, T. A.

J. Chem. Educ. 49, 832 (1972)

A "first experiment" using analytical balance. The efficiency of the light bulb is calculated as the ratio of visible light energy to total emitted energy calculated from Planck radiation equation as measured (weight) from "visible" and total energy portions of curves. Heat emitted measured by calorimetry. Study questions and suggested extensions. Caution: electric light bulbs near water are a shock hazard.

***PHYS DEMO TECHNIQUE TRANSPORT 3**

"Two-Penny" Experiments in Chemical Engineering

Lemlich, R.

J. Chem. Educ. 34, 489 (1957)

Demos described for demonstration purposes in a units operations course—that is, on a small scale rather than in a pilot plant. Demos include fluid flow, heat transfer, distillation, etc. Minimal procedures.

***PHYS DISTRIB NOPROC UVIS 3**

A Laboratory Experiment Using Indicators

Leonard, C. B., Jr.

J. Chem. Educ. 44, 363 (1967)

Two indicators used to measure countercurrent distribution patterns by colorimetry.

***PHYS ANAL ACBA ELECTROCHEM ELECTRODE INSTR 3 HAZARD**

Theory and Practical Use of an Hydrogen Electrode in Aqueous-Organic Media

Letellier, P.; Millot, F.; Baffier, N.; Combes, R.

J. Chem. Educ. 58, 576 (1981)

A 7-hr exp't in which the students prepare their own hydrogen electrodes, use them vs. a calomel reference electrode to study autoprotolysis in a mixed solvent (usually methanol-water) to check the operation of the electrodes, and finally use the electrodes to find the ionization constant of 3-aminobenzoic acid. HAZARD: at the educational level the experiment is aimed at, hydrogen is an explosive hazard.

***PHYS THERMO VAPORPRESS 2**

A Simple Experiment for Determining Vapor Pressure and Enthalpy of Vaporization of Water

Levinson, G. S.

J. Chem. Educ. 59, 337 (1982)

Invert a 10-ml cylinder containing a small amount of trapped air in a large beaker of water and measure change in volume vs. temperature in the 50-80 deg. C. range. Explicit instructions.

***PHYS COMPUTER EXCHANGE KIN NMR 4**

Kinetics of Proton Exchange of Trimethylammonium Ion by NMR: A laboratory experiment

Leyden, D. E.; Morgan, W. R.

J. Chem. Educ. 46, 169 (1969)

Spectra of methyl and water protons at varying pH measured. Line shape (FORTRAN program available) used to calculate relaxation times.

***PHYS GAS VACTEK VAPORPRESS 2 3**

A Simple Isoteniscope and An Improved Method of Vapor Pressure Determination Experiment

Lindauer, M. W.

J. Chem. Educ. 37, 532 (1960)

Simple apparatus. Manometer, thermostatted bath, organic liquids.

Caution: avoid CCl₄, a carcinogen.

***PHYS APPARATUS DIFFUSION UVIS 4**

The Diffusion Coefficient of Sucrose in Water: A Physical Chemistry Experiment

Linder, P. W.; Nassimbeni, L. R.; Posen, A.; Rodgers, A. L.
J. Chem. Educ. 53,330 (1976)

Theory discussion not simple. Stainless steel diffusion cell. Concentration measured colorimetrically. One 3-hr. lab period.

***PHYS ELECTROANAL KIN TECHNIQUE 4**

An Undergraduate Experiment in Chemical Engineering Reactor Kinetics

Lindfors, L. E.
J. Chem. Educ. 48,472 (1971)

Flow rates in a reactor monitored conductimetrically to obtain sec. order rate constant for reaction of EtOAc and NaOH. Chemical engineering exp't, to measure characteristics of batch, plug flow, and backmix reactors.

***PHYS ORG COMPUTER HPRESS KIN NMR NONAQ VACTEK 4 5**

A High Pressure, Nonaqueous Reaction Rate Experiment For Advanced Students

Litchman, W. M.; Teague, S. V.
J. Chem. Educ. 49,560 (1972)

Study of rate of $\text{CH}_3\text{Cl} + \text{NH}_3 \rightarrow \text{CH}_3\text{NH}_3\text{Cl}$ followed by NMR. FORTRAN program for calculating rate constant included. Complete and detailed. Caution: chloroform, carcinogenic, handled on vacuum line.

***PHYS KIN REDOX UVIS 3 HAZARD**

Kinetics of Oxidation of Benzyl Alcohol

Liu, M. T. H.
J. Chem. Educ. 48,703 (1971)

Oxidant: KMnO_4 . Rx is carried out in dil. HClO_4 , followed either by I2 titration or colorimetrically. Rate law, activation energy determined.

HAZARD: HClO_4 is a storage hazard.

***PHYS DEMO DRYLAB OPTICAL QUANTUM 1**

Some Experiments in Atomic Structure

Logan, K. R.
J. Chem. Educ. 51,411 (1974)

A color-film camera is used with a grating to record standardized spectrograms from discharge tubes. Slides are then made up, used as the basis of a drylab by students to measure first 4 lines of Balmer series, calculate Rydberg constant, ionization energy, etc.

***PHYS ELECTROCHEM TRANSPORT 3 HAZARD**

Transport Numbers and Ionic Mobilities by the Moving Boundary Method

Loneragan, G. A.; Pepper, D. C.
J. Chem. Educ. 42,82 (1965)

Absolute ionic mobilities. Special cell, Cd anode. Power supply.
HAZARD: Cd metal and solutions extremely toxic.

***PHYS COMPUTER DRYLAB ERROR KEQ UVIS 4**

The Rigorous Evaluation of Spectrophotometric Data to Obtain an Equilibrium Constant

Long, J. R.; Drago, R. S.
J. Chem. Educ. 59,1037(1982)

Absorption data given, and form for student computation via computer. Much development of theory. Computer programs referenced.

***PHYS APPARATUS NOPROC SURFACE THERMO 4**

A Gas Adsorption Apparatus and Experiment

Lutrick, H. G.; Williams, K. C.; Maatman, R. W.
J. Chem. Educ. 41,93 (1964)

Student-built apparatus. Compressed gases. BET theory. Thermal conductivity cell.

***PHYS FREERAD KIN 2**

The Thermal Decomposition of Azobisisobutyronitrile: A simple kinetics experiment

MacCallum, J. R.
J. Chem. Educ. 48,705 (1971)

Commonly available AIBN decomposes to N_2 gas and a free radical. Simple apparatus.

***PHYS ANAL ORG INSTR IR 4**

Undergraduate Infrared Spectroscopy Experiments

MacCarthy, P.; Bowman, S. J.
J. Chem. Educ. 59,799 (1982)

Two advanced experiments designed to provide experience in deuteration and derivatization methods, vacuum techniques, etc. Schematic of apparatus used in handling deuterated samples given. Detailed, with complete hazard analysis. List of candidates for deuteration given: type used is 2-hydroxybenzyl alcohol. Expt. 2 is the methylation of phenylboric acid.

***PHYS CALORIMETRY THERMO 2**

A Simple Ice Calorimeter: A first experiment in Thermochemistry
Mahan, B. H.
J. Chem. Educ. 37,634 (1960)
Heat of reaction, eg. magnesium metal and hydrogen ion, measured by volume change of ice-water mixture in an inexpensive calorimeter.

***PHYS KEQ THERMO 2**

Temperature Dependence of Equilibrium: A first experiment in general chemistry
Mahan, B. H.
J. Chem. Educ. 40,293 (1963)
Data for cooling curves are obtained for pure naphthalene and 3 mixtures of diphenylamine:naphthalene. Enthalpy of fusion evaluated from data. No special equipment.

***PHYS ACBA CALORIMETRY KEQ THERMO 3**

A Continuous Variation Study of Heats of Neutralization
Mahoney, D. W.; Sweeney, J. A.; Davenport, D. A.; Ramette, R. W.
J. Chem. Educ. 58,730 (1981)
Temp. changes measured as function of acid-base mole ratios mixed for reactions of NaOH with HCl, HOAc, H₃PO₄, H₂SO₄. Results presented as Job plots. Special cases of weak and polyprotic acids discussed. Additional material available from authors.

***PHYS APPARATUS GAS VISC 4**

Determination of the Viscosity Coefficients of Gases
Malinauskas, A. P.; Whisenhunt, S. J., Jr.; Searcy, J. Q.
J. Chem. Educ. 46,781 (1969)
Apparatus requires glassblowing; easy to use. Ar, CO₂, N₂, air, O₂, Ne behave normally. He shows abnormal behavior. Theory developed.

***PHYS INORG COORD KIN UVIS 3**

An Undergraduate Kinetics Experiment Demonstrating Unusual Behavior of the Observed Equilibrium Constant
Malin, J. M.; Toma, H. E.; Giesbrecht, E.
J. Chem. Educ. 54,385 (1977)
Formation of deep-blue pentacyano(N-methylpyrazinium)ferrate(II) from light-yellow similar S-bonded DMSO complex followed spectrophotometrically. Preparations of reactants by reference.

***PHYS INORG CATAL DEMO PROJ REDOX 1 2**

A Demonstration of an Autocatalytic Reaction
Maric, D.; Strajnar, F.
J. Chem. Educ. 60,994 (1983)
The redox reaction of chlorate, bisulfate and sulfite ions to chloride, sulfate and hydrogen ions proceeds with an increase in acidity that catalyzes the reaction. Bromphenol blue is used to monitor the progress of the rxn. A Tested Demonstration. Could be the basis of an experiment or project.

***PHYS COMPUTER NOPROC QUANTUM 4**

Analog Computer Solution of a Particle in a Finite Well: A physical chemistry experiment
Marron, M. T.
J. Chem. Educ. 50,289 (1973)
2 lab periods focus on how to use computers, patch boards, etc. Use computer to solve Schroedinger equation. Write-up avail. from author. Systron-Donner #3300 analog computer.

***PHYS DRYLAB XRAY 5**

Interpretation of a Patterson Map - A Dry-Lab Experiment in X-ray Crystallography
Marsh, R. E.; Nordman, C. E.
J. Chem. Educ. 54,318 (1977)
Student who has completed a 10-wk course in X-ray diffraction will req. approx. 10-15 hrs to complete this problem.

***PHYS APPARATUS GAS VACTEK 3**

A Student Apparatus for Measuring the Second Virial Coefficients of Vapors
Martin, M. L.; Dunlop, P. J.
J. Chem. Educ. 46,615 (1969)
Nitrogen and pure hexane carefully dried, introduced into special apparatus with volume measurement and mercury manometer. Theory also.

***PHYS ANAL COMPLEX DEMO NOPROC SOLUB STOICH 2**

A Simple Demonstration of Some Precipitation and Solubility Effects
Matijevic, E.; Kratochvil, J. P.; Kerker, M.
J. Chem. Educ. 38,397 (1961)
Method of continuous variation applied to the Ag⁺/Br⁻ system. Special attention is paid to those parts of the solubility diagram where complex formation and AgBr sol'n's occur. No procedure, either for exp't or demo.

***PHYS APPARATUS AVOGADRO MICROSCOPE STATISTICS 3**

Brownian Motion: An Undergraduate Laboratory Experiment

Matthews, G. P.

J. Chem. Educ. 59,246 (1982)

Average displacement of a particle in suspension measured, used in Einstein formula. Needs an eyepiece graticule with a square grid. Excellent, detailed presentation of an experiment to accompany teaching of kinetic molecular theory in first-year Physical Chemistry. Needs more background in probability and statistics than most first-semester freshmen have.

***PHYS INORG DEMO NOPROC PROJ THERMO 2**

Demonstrations of Spontaneous Endothermic Reactions

Matthews, G. W. J.

J. Chem. Educ. 43,476 (1966)

Short note. Transition metal chlorides (hydrated) react spectacularly with thionyl chloride, mostly endothermically, often with HCl evolved. This is proposed either as a demo or a student project in thermochemistry. WARNING: Take sensible precautions with these reactions. If this article had been more explicit, we would have tagged it with "HAZARD".

***PHYS ORG KIN NOPROC UVIS 3 4**

Penicillin Hydrolysis; A Kinetic Study of a Multistep, Multiproduct Reaction

McCarrick, T. A.; McLafferty, F. W.

J. Chem. Educ. 61,463 (1984)

A microprocessor controlled rapid scanning UV-VIS spectrometer is used to study the hydrolysis of benzylpenicillin, and determine the rate constant. Hydrolysis mechanisms are discussed, and additional experiments suggested.

***PHYS ANAL COMPUTER ELECTROCHEM KIN TECHNIQUE 4**

Reaction Rate of Ethyl Acetate Hydrolysis by Oscillometry

McCormick, P. G.

J. Chem. Educ. 48,558 (1971)

Determination of second-order rate constant in alk. hydrolysis of ethyl acetate. Req. oscilometer and recorder. Ambient temperature.

***PHYS ORG NOPROC PHASE SEPARATION 2**

The Azeotrope - An Introduction to Distillation

McCullough, T.; Nowicki, J. E.

J. Chem. Educ. 51,323 (1974)

Determination of azeotrope composition and B.P. for various substances with water.

***PHYS ORG KIN PROJ 3 4**

An Introductory Level Kinetics Investigation

McGarvey, J. E. B.; Knipe, A. C.

J. Chem. Educ. 57,155 (1980)

Rate of unimolecular decarboxylation of 3-bromo-3-phenyl propanoic acid in aqueous ethanol(ph 7-9) measured by evolution of CO₂ using very simple apparatus. Authors claim good system for relating kinetics to mechanism. Suitable for student projects.

***PHYS LUMIN NOPROC SURFACE UVIS 4**

Luminescence Experiments Using Adsorbed Dyes

McHale, J. L.; Seybold, P. G.

J. Chem. Educ. 53,654 (1976)

Alpha-naphthol and naphthalene dyes phosphoresce as well as fluoresce when adsorbed on cellulose, silica, alumina. Spectra can be recorded and phosphorescent lifetimes can be measured in experiments outlined.

***PHYS DEMO KIN 2**

Thermodynamic verses Kinetic Control: A Lecture Demonstration.

McNaught, I. J.

J. Chem. Educ. 55,722 (1978)

Reaction of mercuric ion with iodide ions can yield either rhombic HgI₂ (yellow) or tetragonal HgI₂ (orange) depending on concentrations.

***PHYS ORG DRYLAB IR QUANTUM 4**

Structural Parameters of Methyl Iodide by Infrared Spectroscopy

McNaught, I. J.

J. Chem. Educ. 59,879 (1982)

Treatment of data given in detail. Suitable for a dry-lab.

***PHYS ELECTROCHEM THERMO 3**

Thermodynamics of a Galvanic Cell: A physical chemistry experiment

McSwiney, H. D.

J. Chem. Educ. 59,165 (1982)

Determination of delta G, delta S, delta H for zinc-ferricyanide reaction by measuring temp. coefficient of EMF. Simple experiment.

***PHYS APPARATUS DIFFUSION HEAT LASER PHOTO 3 4**

A Simple Photoacoustic Microscopy (PAM) Experiment

Mei, E. H.; Eyring, E. M.
J. Chem. Educ. 58,812 (1981)

Presents simplified theory of photoacoustic spectroscopy and simple apparatus using about \$6000 of electronics and 2mW He-Ne laser.

***PHYS IR RAMAN 3 4**

Vibrational Spectroscopy of CS₂: A physical chemistry experiment

Mendelsohn, R.; Monse, E. U.
J. Chem. Educ. 58,582 (1981)

IR and RAMAN spectra of CS₂ (neat and in CCl₄ soln) illustrate concepts of vib-rot spectroscopy. Claim that CS₂ more useful pedagogically than usual IR expt's using diatomics, e.g., HCl. Caution: CS₂ is toxic.

***PHYS APPARATUS DEMO GAS PROJ VAPORPRESS 2**

An Effective Demonstration of Some Properties of Real Vapors

Metsger, D. S.
J. Chem. Educ. 60,67 (1983)

Vacuum line, Hg manometer used to demo gas laws. Gas used is Br₂ vapor, as it is highly colored: students can see what is happening as P, V, etc. are altered. Article warns that Br₂ is a strong oxidant and must be handled properly. A Tested Demonstration. Suggestions for other demos could be the basis for student project at this level.

***PHYS COLLIG PHASE THERMO 3 4**

A Binary Solid-Liquid Phase Diagram Experiment Including Determination of Purity, Enthalpy of Fusion, and True Melting Point

Meyer, E. F.; Meyer, J. A.
J. Chem. Educ. 57,831 (1980)

n-Tetracosane and di-n-dodecyl thioether form a nearly ideal mixture with a convenient temperature range for small scale work and freedom from toxic or unstable compounds. Thermodynamic analysis and calculations. See also Meyer, E.F. and Meyer, J.A., J. Chem. Ed., 61,459 (1984) for additional discussion.

***PHYS CRYO 2**

Molecular Weights by Cryoscopy: A general chemistry laboratory experiment

Mikulak, R.; Runquist, O.
J. Chem. Educ. 38,557 (1961)

Cyclohexanol has a large cryoscopic constant (39), and melts near room temperature. Simple method described to protect system from atm. moisture. Solute: benzoic acid, unknowns.

***PHYS COORD DEMO KEQ THERMO 2**

Reversible Formation of Aluminum Xylenol Orange by Temperature Variation: An Experiment Demonstrating the Entropy Effect

Miller, F. I.; Fog, H. M.
J. Chem. Educ. 50,147 (1973)

Keq for reaction of aluminum ion with xylenol orange (multidentate) can be evaluated by spectroscopic determination of the orange complex at 550 nm. Stoichiometry and thermodynamic properties are calculated. Demo: shows color change on heating as an entropy effect.

***PHYS QUANTUM UVIS 4**

The Spectrum of Atomic Lithium: An undergraduate laboratory experiment

Miller, K. J.
J. Chem. Educ. 51,805 (1974)

Bausch and Lomb 1.5M Spectrograph yields line spectrum on photographic film. Student is to construct a complete energy-level diagram for atomic lithium.

***PHYS CLOCK DEMO DENSITY 2**

Density Gradients in Chemistry Teaching

Miller, P. J.
J. Chem. Educ. 49,278 (1972)

Assorted things to do with density columns - columns of liquids with a composition and density gradient. Includes an interesting variation on the iodine clock.

***PHYS INORG ASSOC CRYSTAL HITEMP IR QUANTUM SOLID 4**

Infrared Spectra of Simple Inorganic Ion Pairs in Solid Solution: A physical inorganic chemistry experiment

Miller, P. J.; Tong, W. G.
J. Chem. Educ. 57,523 (1980)

Simple furnace described for growing single alkali halide crystals doped with divalent tetrahedral oxyanions. Group theory used to analyse high resolution IR spectra (cleaved sections) of anions paired with divalent cations in solid solution.

***PHYS GAS KEQ PH 1 2**

A Discovery Experiment: CO₂ Soap Bubble Dynamics

Millikan, R. C.
J. Chem. Educ. 55,807 (1978)

Qualitative. Fun. Used at UC to provide positive motivation, change of pace. Dry ice, commercial "bubble-stuff". Why do bubbles grow?

***PHYS CATAL DEMO ELECTROANAL KIN OSC.RXN REDOX 3**

Belousov's Oscillating Reaction in Acidic Medium Other Than Sulfuric Acid

Mishra, H. C.; Singh, C. M.
J. Chem. Educ. 54,377 (1977)

Mn(II)-catalyzed reaction between citric acid and potassium bromate in phosphoric and nitric acids followed potentiometrically and by change of color of solution.

***PHYS KIN UVIS 2**

First-Order Decomposition of the Violet Colored Ce(IV) Oxidation Product of N-Phenylanthranilic Acid.

Mishra, S. K.; Sharma, P. D.; Gupta, Y. K.
J. Chem. Educ. 53,327 (1976)

The endpoint color in std. Ce(IV) by Fe(II) to the N-phenylanthranilic acid decays with time, following first order kinetics, $k = (2.63 \pm 0.16) \times 10^{-3}$ recip. sec.; Spec-20 required. The nature of the decomp. of the oxidized form is not known.

***PHYS DEMO GAS 1**

An Exercise with Boyle's Law

Moeller, M. B.
J. Chem. Educ. 55,584 (1978)

A calculation of change in volume and pressure in a system where water flows into a closed container, compressing it, is followed by a simple experimental measurement. A tested demonstration.

***PHYS CLOCK KIN 2 3**

The Oxidation of Iodide Ion by Persulfate Ion

Moews, P. C.; Petrucci, R. H.
J. Chem. Educ. 41,549 (1964)

Iodine-clock, with concentrations adjusted to give short reaction times. Rate of oxidation of iodide by persulfate followed by adding an aliquot of std. thiosulfate and starch. Activation energy effect of Cu(II) (catalyst) and ionic strength.

***PHYS DIPOLE GEOM KEQ THERMO 3 HAZARD**

Thermodynamics From Dipole Moments

Moffat, J. B.
J. Chem. Educ. 43,74 (1966)

Measured dielectric constants of mixtures of cis- and trans- isomers of propyl nitrite (HAZARD: cardio-respiratory stimulant) used with bond dipole moments to calculate isomer composition and free energy of isomerization.

***PHYS GC PHASE 3 HAZARD**

Determination of Liquid-Vapor Phase Diagram

Molski, N. J.; Swain, H. A., Jr.
J. Chem. Educ. 45,48 (1968)

Phase diagram from gc (peak height) analysis of distillate fractions. Benzene (HAZARD: carcinogen)-toluene.

***PHYS CORROSION KIN UVIS 2 HAZARD**

Dissolving Iron Nails: A kinetics experiment

Monaghan, C. P.; Fanning, J. C.
J. Chem. Educ. 55,400 (1978)

Rate of reaction of iron metal with dilute HCl yielding Fe^{++} , H_2 followed by oxidation of Fe^{++} to ferric, colorimetric by thiocyanate. Rate is proportional to surface area, inversely to volume of solution. HAZARD: liq. Br₂.

***PHYS QUANTUM RAMAN UVIS 4 5**

Vibronic Spectra and Energy Levels of Polyatomic Molecules: A physical chemistry experiment

Moomaw, W. R.; Skinner, J. F.
J. Chem. Educ. 48,304 (1971)

Student measures and assigns vapor-phase vibronic spectrum of pyrazine and chlorobenzene. Vapor spectra at 373 K.

***PHYS APPARATUS GAS THERMO 2 3**

The Adiabatic Expansion of Gases and the Determination of Heat Capacity Ratios; A Physical Chemistry Experiment

Moore, W. M.
J. Chem. Educ. 61,1119(1984)

A simple experiment to study the adiabatic expansion of gases in order to obtain heat capacity ratios. Results are in good agreement with the literature. A pressure transducer is required.

***PHYS APPARATUS FASTREACTION KIN 4**

A Kinetic Experiment Using a Spring-Powered, Stopped-Flow Apparatus

Morelli, B.

J. Chem. Educ. 53,119 (1976)
Design given for a very inexpensive and easy-to-build stopped-flow apparatus for the study of very fast reactions; suggested uses, undergraduate instruction and research. Emphasis on construction of equipment. Oscillograph.

31
*PHYS ACBA COORD KEQ 3 HAZARD

The Effect of Ligands on Hydrolysis Constants of Transition Metal Ions
Morrow, J. I.

J. Chem. Educ. 49, 748 (1972)

Determination of the acid ionization constant for $\text{Cr}(\text{H}_2\text{O})_6^{3+}$, by measuring pH of dilute $\text{Cr}(\text{ClO}_4)_3$ solutions. L&N pH meter. Cr^{3+} solutions must be aged three months. Caution: perchlorates, storage hazard.

*PHYS MASSPEC QUANTUM 4

A Mass Spectroscopy Experiment

Morse, R. I.

J. Chem. Educ. 48, 398 (1971)

Quadrupole mass spec. CH_3OH , $\text{C}_2\text{H}_5\text{OH}$, 1-propanol, 1-butanol. Rice-Ramsperger-Kassel theory of fragmentation.

*PHYS CLOCK DEMO KIN 1

The Landolt, "Old Nassau", and Variant Reactions

Moss, A.

J. Chem. Educ. 55, 244 (1978)

Variants of iodine-clock, and other clock expts, described.

*PHYS APPARATUS CALORIMETRY ELECTROANAL. THERMO 4

Heat of Reaction in Aqueous Solution by Potentiometry and Calorimetry.

II. A redox reaction

Moss, S. J.; Hill, D. L.

J. Chem. Educ. 42, 544 (1965)

Ferrous-ceric reaction in H_2SO_4 . Enthalpy two ways: temperature coefficient of emf vs. direct calorimetry. High-quality apparatus.

Three-hour experiment. See part I.

*PHYS ANAL INORG CRYSTAL DENSITY INTEGR PREP XRAY 4

Synthesis and Structure of Magnesium Oxide or Calcium Oxide: An integrated inorganic-physical experiment

Moyer, R. O.

J. Chem. Educ. 52, 612 (1975)

Oxides are prep'd by thermal decomposition of the oxalates. Muffle furnace. Density on pressed pellets. X-ray diffraction. Elemental analysis by reference.

*PHYS DENSITY ELECTROCHEM MOLTENSALT VISC 4

A Low Temperature Fused Salt Experiment: The Conductivity, Viscosity, and Density of Molten Calcium Nitrate Tetrahydrate

Moynihan, C. T.

J. Chem. Educ. 44, 531 (1967)

This is a classic paper in low-temp. molten-salt chemistry. $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ melts at 42.7 deg. C. Conductivity cell, Wheatstone bridge, Ubbelohde viscometer, Westphal balance.

*PHYS AVOGADRO REVIEW 2

Determining Avogadro's Number from the Volume of a Monolayer

Moynihan, C. T.; Goldwhite, H.

J. Chem. Educ. 46, 779 (1969)

Recommendations about best technique (J. Chem. Educ., 39, 18(1962)) for a classical experiment and about method of calculation. For later suggestions, see Lane, C. A., Burton, D. E., and Crabb, C. C., J. Chem. Ed. 61, 815 (1984).

*PHYS DEMO GAS 2

A Charles' Law Experiment Using a Balloon or a Plastic Bag

Murdock, H. D.; Hawthorne, R. M. Jr.

J. Chem. Educ. 50, 528 (1973)

Straightforward; could be used for a "first" experiment.

*PHYS COMPUTER KIN TITN 3

A Computer Program for Chemical Kinetics by Titration

Musulin, B.

J. Chem. Educ. 46, 109 (1969)

Program (available) calculates rate constants for saponification of ethyl and propyl acetate assuming second order and also (for pedagogic purposes) assuming equilibrium. Effects of number of data points, different methods of solution shown.

*PHYS POLYMER POLARIM UVIS 3 4 HAZARD

Linear Dichroism of Cyanine Dyes in Stretched Polyvinyl Alcohol Films:

A Physical Chemistry Laboratory Experiment

Natarajan, L. V.; Robinson, M.; Blankenship, R. E.

J. Chem. Educ. 60, 241 (1983)

Cyanine dyes commercially available are dissolved in aqueous polyvinyl alcohol. Cast films on glass are dried, stretched, and measured in recording spectrophotometer with polarizer. Molecular orientation and shape deduced from spectra. Good discussion. Polyethylene/nonpolar dye system extension uses chloroform (HAZARD, not described) as solvent.

*PHYS ORG PHOTO UVIS 3

Quenching of Benzophenone Triplets by Naphthalene: A physical-organic chemistry experiment

Natarajan, P.

J. Chem. Educ. 53,200 (1976)

Mercury vapor lamp for photochemical reduction of benzophenone in 2-propanol.

*PHYS CATAL KIN REDOX 2

Reaction Rates for a Homogeneously Catalyzed Reaction

Nechamkin, H.; Keller, E.; Goodkin, J.

J. Chem. Educ. 54,775 (1977)

The reaction of permanganate ion with hydrogen (generated in situ from metal and acid) catalyzed by nitrate ion is measured by time for loss of permanganate color. Order of reaction with respect to permanganate and nitrate is measured.

*PHYS CALORIMETRY REVIEW 2 3

Thermochemical Investigations for a First-Year College Chemistry Course: A survey of existing literature

Neidig, H. A.; Schneider, H.; Teates, T. G.

J. Chem. Educ. 42,26 (1965)

A survey of literature on thermochemical experiments in J. Chem. Educ. and other sources. 39 references.

*PHYS ANAL INORG INTEGR KEQ 2 3

The Chemistry of Orthophosphoric Acid and Its Sodium Salts

Neidig, H. A.; Teates, T. G.; Yingling, R. T.

J. Chem. Educ. 45,57 (1968)

Suggests possible lab expts from 1st year to 3rd year courses involving dissociation, hydrolysis, and disproportionation. Minimal directions.

*PHYS ACBA CALORIMETRY SOLID THERMO 2

Enthalpies of Formation of Solid Salts

Neidig, H. A.; Yingling, R. T.

J. Chem. Educ. 42,474 (1965)

Measure heat of neutralization NH_3 aq. plus hydrochloric or nitric or sulfuric acid, and also heat of solution of salts, with tabulated thermo data can calc. enthalpy of formation of ammonium salts.

*PHYS ANAL KEQ PHASE SOLUB 3 HAZARD

Investigation of Interaction in the $\text{Pb}(\text{NO}_3)_2$ -NaCl-Methanol-Water System

Neidig, H. A.; Yingling, R. T.

J. Chem. Educ. 42,475 (1965)

Solubility data collected via class project. Gravimetric analysis plus chloride titration. Finally, construct a model for the system and interpret the results in terms of the model. HAZARD: asbestos in Gooch filter; use alternative filtration method.

*PHYS CALORIMETRY KEQ NOPROC THERMO TITN 2

Thermodynamics of the Ionization of Acetic and Chloroacetic Acids

Neidig, H. A.; Yingling, R. T.

J. Chem. Educ. 42,484 (1965)

Students determine K_a by pH meter titration, enthalpy of neutralization by thermal cup procedure.

*PHYS NOPROC PROJ THERMO 2

Relationship of Enthalpy of Solution, Solvation Energy, and Crystal Energy

Neidig, H. A.; Yingling, R. T.

J. Chem. Educ. 42,473 (1965)

Thermocup exp't. Solvation energies for calcium chloride and its dihydrate in three solvents (water, ethanol, methanol) from cooling curves, literature data.

*PHYS KEQ PHASE SOLUB THERMO 3

Interaction in Chemical Systems

Neidig, H. A.; Yingling, R. T.; Lockwood, K. L.; Teates, T. G.

J. Chem. Educ. 42,368 (1965)

Second paper in series of measuring interactions in methanol-water.

Here uses solubilities of inorganic salts in mixed solvent to calc. thermodynamic quantities and a model of structural interactions. Much discussion.

*PHYS GAS KEQ THERMO VACTEK 2

Lecture Experiment: A Quantitative Illustration of Le Chatelier's Principle

Nelson, D. L.; Ginns, E. I.; Richtol, H.; Reeves, R. R.

J. Chem. Educ. 50,721 (1973)

Simple apparatus allows demo of measurement of P-total of system $\text{N}_2\text{O}_4 = 2\text{NO}_2$ equilibrium mixtures versus temperature. Data allows calculation of degree of dissociation of N_2O_4 . Caution: toxic gases.

***PHYS ORG CATAL IONX KIN 3**

Heterogeneous Catalysis: Resin-Catalyzed Saponification of Methyl Acetate
Nieto, A.
J. Chem. Educ. 50,846 (1973)
Straightforward. Simple apparatus. Within capacity of many freshmen.

***PHYS APPARATUS DIFFUSION MICROSCOPE 3**

Diffusion Under the Microscope
Nishijima, Y.; Oster, G.
J. Chem. Educ. 38,114 (1961)
Inexpensive apparatus allows diffusion coeff. measurement in short time.
Experiments with true liquids. Metallized microscope slides; interference pattern; Hg lamp and filter.

***PHYS POLYMER NOPROC PROJ THERMO 3**

Demonstration of PV Work by Balloon Inflation
O'Driscoll, K. F.
J. Chem. Educ. 36,626 (1959)
Inflating a balloon is made to displace water. Apparatus easily made, reference.

***PHYS APPARATUS EXPLOSION KIN THERMO VACTEK 4**

The Hydrogen-Oxygen Second Explosion Limit: A physical chemistry experiment
Ogilvie, J. F.
J. Chem. Educ. 48,342 (1971)
Diagram of gas-handling system given. Activation energy by varying temp.
Caution: explosion potential of hydrogen.

***PHYS APPARATUS GAS HITEMP VISC 4**

Determining the Intermolecular Potential Energy in a Gas:
A physical chemistry experiment.
Olbregts, J.; Walgraave, J. P.
J. Chem. Educ. 53,602 (1976)
Viscosity of propane as a function of temperature to 650 deg. Celsius.
Diagrams of viscometer and electronic clock given. Parameters of Lennard Jones intermolecular potential; virial coefficients calc'n.
Data given.

***PHYS ANAL ACBA DEMO KEQ PH 2**

Weak and Strong Acid and Buffers
Ophardt, C. E.
J. Chem. Educ. 53,229 (1976)
Metacresol purple, bromocresol green used to show acidity of various mixtures of HCl/HOAc/NaOAc.

***PHYS ACTIVITY APPARATUS LIQUID VAPORPRESS 3 HAZARD**

Activity Coefficients of Acetone-Chloroform Solutions:
An Undergraduate Experiment
Ozog, J. Z.; Morrison, J. A.
J. Chem. Educ. 60,72 (1983)
Construction of an apparatus to study liquid-vapor equilibrium is described. Acetone-chloroform system (HAZARD: potential carcinogen, flammable). 3 lab periods.

***PHYS APPARATUS SOLUB 2**

Experiment on Solubility as a Function of Temperature
Pacer, R. A.
J. Chem. Educ. 48,225 (1971)
Reports successful class use of Bronsted-Davies saturator in an extension of a classical solubility experiment (Wolthius, 1960).

***PHYS INORG KEQ SOLUB UVIS 1 2**

The Solubility of $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$: A General Chemistry Experiment
Pacer, R. A.
J. Chem. Educ. 61,467 (1984)
Solubility as a function of temperature is measured, over a relatively small range, using a Spec 20. Good for developing concepts, particularly equilibrium. Lab handout available.

***PHYS COMPUTER KIN RADIOCHEM STATISTICS 2**

Some Simple Classroom Experiments on the Monte Carlo Method
Para, A. F.; Lazzarini, E.
J. Chem. Educ. 51,336 (1974)
Freshman nuclear physics or chem course, calculation of decay, statistical fluctuation of decay rate.

***PHYS INORG CORROSION DEMO ELECTROCHEM 3**

Cathodic Protection Against Corrosion: An Experiment

Pare, J. R. J.; Jankowski, K.

J. Chem. Educ. 59, 798 (1982)

Experiment designed for upper-level engineering students or as a demo for first year students, to find a cheap material to use as a sacrificial anode to prevent rusting in cars. Expt. takes about 6 months and requires access to a machine shop.

***PHYS ORG ASSOC GEOM IR 3**

A Simple Demonstration of Conformational Equilibrium

Partridge, D. A.

J. Chem. Educ. 57, 508 (1980)

IR spectra of pinacol in CCl_4 demonstrate conformational equilibrium by shifts in OH stretching frequency due to conformational dependent intramolecular H-bonding.

***PHYS APPARATUS FASTREACTION KEQ 5**

Fast Reactions: Rapid Mixing and Concentration Jump Experiments

Patel, R. C.; Atkinson, G.; Boe, R. J.

J. Chem. Educ. 47, 800 (1970)

Advanced technique experiment. Apparatus construction described. Rate of dehydration of carbonic acid, concentration jump expt. with carbonic acid, and concentration jump expt. with pyruvic acid described.

***PHYS POLYMER CHEM.ENG LIQUID VISC 3 4**

The Viscosity of Polymeric Fluids

Perrin, J. E.; Martin, G. C.

J. Chem. Educ. 60, 516 (1983)

Water solutions of polyacrylamide are non-Newtonian fluids; glycerol solutions are Newtonian. Viscosity measurements (Brookfield viscometer) of these two solutions as a function of shear rate illustrate the difference and permit calc. of the exponential relation for the non-Newtonian fluid. A chem. engineering experiment, useful in phys chem also.

***PHYS CRYSTAL ELECTROCHEM HITEMP SOLID 4**

An Experiment in Solid State Chemistry: The Mobilities of Ionic Defects in Silver Bromide

Perrino, C. T.; Peacock, S.

J. Chem. Educ. 50, 508 (1973)

AC conductivity measurements on silver bromide doped with CdBr_2 melted and cooled with electrodes in place. Requires lots of silver; temperatures over 220-250 degrees C.

***PHYS CRYSTAL ELECTROCHEM HITEMP SOLID 4**

An Experiment in Solid State Chemistry: Conduction in Silver Iodide

Perrino, C. T.; Wentreck, P.

J. Chem. Educ. 49, 543 (1972)

Explicit directions for determination of ionic conductivity in solid AgI, 100-160 degrees C. Standard DC technique. Defect chemistry of solids.

***PHYS ANAL INORG KSP PREP 2**

The Solubility Product Constant for Copper Iodate

Peterson, B. H.

J. Chem. Educ. 34, 612 (1957)

Copper(II) iodate prepared. Solution in equilb. with solid analyzed iodimetrically (directions minimal).

***PHYS ELECTROCHEM 2**

A Simple Quantitative Electrolysis Experiment for First-Year Chemistry

Petrucchi, R. H.; Moews, P. C.

J. Chem. Educ. 41, 552 (1964)

Two beakers cont. aq. Na_2SO_4 , metal foil electrodes, 6-volt batteries, agar salt bridge. Aliquot of std. acid + indicator added to cathode compartment. Student determines acid conc. by noting time, current needed to change ind. color. Compared to standard.

***PHYS ORG PHOTO UVIS 3**

A Quantitative Photochemical Experiment for Undergraduates

Phillips, D.

J. Chem. Educ. 48, 198 (1971)

Biacetyl, irradiated at 300 nm, undergoes enolization. The enol has a strong UV absorption band, used to follow the reaction. Quantum yield via ferric actinometer.

***PHYS ORG CALORIMETRY 3**

A Novel Bomb Calorimetric Determination of the Resonance Energy of Benzene

Pickering, M.

J. Chem. Educ. 59, 318 (1982)

Modification of Stevenson, G.R., J. Chem. Educ. 49, 781 (1972) to use 1,5,9-trans,trans,cis-cyclododecatiene, find resonance energy of benzene by difference.

***PHYS POLYMER ASSOC BIOCHEM FLUOR VISC 3 4**

Protein Denaturation: A Physical Chemistry Project Lab

Pickering, M.; Crabtree, R. H.

J. Chem. Educ. 58,513 (1981)

Molecular weight of bovine serum albumin determined by intrinsic viscosity, and number of disulfide bonds by fluorimetric assay using fluorescein mercuric acetate. Caution: fluorescein mercuric acetate is toxic.

***PHYS PROJ SURFACE 3**

The Measurement of Wettability: A simple method for contact angle determinations

Pirie, B. J. S.; Gregory, D. W.

J. Chem. Educ. 50,682 (1973)

Photographing a drop of liquid on a surface permits contact angle measurement. Suggestions for experiments are given.

***PHYS COMPUTER DRYLAB MOL.SPECT QUANTUM 5**

A Computer Experiment in Microwave Spectroscopy

Polinow, G. F.; Hopfinger, A. J.

J. Chem. Educ. 45,528 (1968)

Very advanced experiment using lit. values and computer program (available) to calculate frequencies, energy levels for unsymmetrical molecules.

***PHYS ORG APPARATUS KIN VACTEK 4**

Laboratory Experiments in Gas Kinetics: Decomposition of di-t-butyl peroxide and norbornylene

Price, A. H.; Baker, R. T. K.

J. Chem. Educ. 42,614 (1965)

Rate of decomp. followed by pressure change. Special apparatus: jacketed reaction chamber on vacuum line. Explosive hazard, shield required. Reader (DT) points out norbornylene is usually called norbornene. See also Ellison, H.R., J. CHEM. EDUC., 48, 205 (1971) for a simplified apparatus.

***PHYS APPARATUS KIN LUMIN NOPROC PROJ UVIS VACTEK 4**

The Fast-Flow Discharge Reactor as an Undergraduate Instructional Tool

Provencher, G. M.

J. Chem. Educ. 58,1024(1981)

Experiments are outlined (excited N₂ with NO in most detail) suitable for class or project.

***PHYS CATAL KIN NOPROC VACTEK 4**

Heterogeneous Kinetics in the Laboratory: The Decomposition of Ammonia on a Tungsten Surface

Pryce-Jones, T.

J. Chem. Educ. 49,848 (1972)

Describes construction of reaction chamber for a gas line from a projector bulb modified by glassblowing. Temperature can be measured from resistance of the filament. Little detail, ref. to phys. chem. lab text.

***PHYS APPARATUS ISOTOPE LASER VACTEK 4**

Molecular Multiple Photon Absorption: An undergraduate physical chemistry experiment in laser isotope separation

Quick, C. R., Jr.; Wittig, C.

J. Chem. Educ. 54,705 (1977)

CO₂TEA laser (purchased or constructed) is required. Excitation of SF₆ photodissociates only S-32F₆, not S-34F₆. Monitor by ir. CAUTION: high energy laser, high voltage.

***PHYS VAPORPRESS 2**

Vapor Pressure Determination

Radley, E. T.

J. Chem. Educ. 37,35 (1960)

The approx. vapor pressure of low-boiling liquids is estimated by measuring the increase of an air column trapped in glass tubing between two mercury drops when the liquid is introduced between them and allowed to volatilize.

***PHYS ANAL KEQ SOLUB TITN 3**

The Instability Constant of the I₃⁻ = I⁻ + I₂ System: A Student Experiment

Ramamurti, G.; Renganathan, K.; Ganesan, L. R.

J. Chem. Educ. 53,326 (1976)

An alternative and simpler method for the classical procedure wherein the iodine is extracted with carbon tetrachloride. This method equilibrates solid iodine with potassium iodide solutions. Aliquots of aq. layer are titrated with standard thiosulfate. Within capacity of many freshmen.

***PHYS ANAL INORG KEQ PREP 3 HAZARD**

The Dissociation Constant of Iodic Acid:

Experiments for the analytical laboratory

Ramette, R. W.

J. Chem. Educ. 36,191 (1959)

Solubility of copper iodate (prepared) in solutions of varying acidity with lithium or sodium perchlorate to give constant ionic strength. Permits graphical estimation of acidity constant.

HAZARD: Perchloric acid is a storage hazard.

***PHYS COMPLEX ELECTROCHEM KEQ 3**

Silver Equilibria via Cell Measurements:

A quantitative laboratory experiment

Ramette, R. W.

J. Chem. Educ. 49,423 (1972)

Equilibrium constant for complex formation of silver(I) with chloride, bromide, and ammonia is measured potentiometrically.

***PHYS COORD KEQ UVIS 3**

Formation of Monothiocyanatoiron(III):

A photometric equilibrium study

Ramette, R. W.

J. Chem. Educ. 40,71 (1963)

The formation complex of the coordination compound is measured colorimetrically as a function of the total iron(III) concentration.

***PHYS ANAL COMPLEX NOPROC 3**

The Nature of Dissolved Silver Acetate

Ramette, R. W.

J. Chem. Educ. 43,299 (1966)

Students are given the problem of possible complex formation and some suggestions on how to proceed experimentally. An determination of silver ion concentration in the presence of varying amounts of acetate at constant ionic strength (sodium perchlorate) is strongly suggested.

***PHYS ACBA GROUP KEQ PROJ UVIS 3**

The Dissociation Quotient of Bromocresol Green:

A class study of ionic strength effects

Ramette, R. W.

J. Chem. Educ. 40,252 (1963)

Measure visible absorption at various pH values and ionic strengths to find the dissociation constant. Graphical method of solution.

***PHYS CALORIMETRY THERMO 3 4**

Solution Calorimetry in the Advanced Laboratory

A Study of Glycine Proton-Transfer Enthalpies

Ramette, R. W.

J. Chem. Educ. 61,76 (1984)

Calorimetry is used to obtain molar enthalpies for the processes glycine (s) to glycine(aq), to glycineH⁺(aq), and to glycine⁻(aq), at 0.03M. Comparison with lit. data.

***PHYS DIPOLE GEOM 3 HAZARD**

Dipole Moments: A physical-organic experiment

Rapp, R. D.; Sturm, J. E.

J. Chem. Educ. 46,851 (1969)

HAZARD: Benzene used as reference is carcinogen. Substitute? Students measure dipole moment of 2-chlorocyclohexanone, calculate ratio of axial and equatorial conformers.

***PHYS INORG DEMO KIN OSC.RXN PROJ 2 HAZARD**

Color Oscillations in the Formic Acid-Nitric Acid-Sulfuric Acid System

Raw, C. J. G.; Kubik, J. P.; Tecklenburg, R. E.

J. Chem. Educ. 60,994 (1983)

Morgan Reaction. Sufficiently hazardous (explosive & toxicity hazards) that the authors suggest making a home movie (or videotape) to be used for the actual demo. A possible project, but not to be undertaken lightly. A Tested Demonstration.

***PHYS APPARATUS DTA 3**

Differential Thermal Analysis With a Fisher Johns Apparatus

Reed, K.

J. Chem. Educ. 41,606 (1964)

Emphasis on modification (substantial). Some student experiments on decomposition and phase transition (not discussed).

***PHYS ORG KEQ NOPROC THERMO UVIS 3**

A Molecular Complex Suitable For Spectrophotometric Investigation

Rehwooldt, R. E.; Boynton, E.

J. Chem. Educ. 42,648 (1965)

2,3-Dichloro-5,6-dicyanobenzoquinone (DDQ) forms green pi complex with naphthalene in CH₂Cl₂. Measurements at two temperatures to calculate Keq, heat of formation. 3 lab periods.

***PHYS ASSOC COORD KIN MICELLE PROJ SURFACE 3 4**

A Convenient Stopped-Flow Experiment: Demonstrating the Influence of Micelles on Reaction Kinetics

Reinsborough, V. C.; Robinson, B. H.

J. Chem. Educ. 58,586 (1981)

Spectrophotometric stopped flow technique used to investigate kinetics of Ni(II) reacting with ligand pyridine-2-azo-p-dimethyl-aniline in aqueous sol'n. Effect of micelles of sodium dodecylsulfate interpreted in terms of adsorption of Ni and ligand on micelle surface. Offers opportunities for student research projects.

***PHYS GRAVIM KSP TITN 1**

Ksp Experiment: The Solubility Product for Barium Hydroxide

Reynolds, J. P.

J. Chem. Educ. 52,521 (1975)

Simple experiment to determine conc. Ba++ and OH- above barium hydroxide.

***PHYS COMPUTER DECAY FLUOR KIN QUANTUM 4**

Determination of the Activation Energy of a Non-radiative Decay Manifold:

A physical chemistry experiment

Ricci, R. W.

J. Chem. Educ. 51,692 (1974)

Effect of temp. on fluorescence yield of indole, analyzed by curve fitting

data to determine constants. See also McHale, J.L.; Seybold, P.G., J.

CHEM. EDUC., 53, 654 (1976).

***PHYS COMPUTER IR ISOTOPE MOL.SPECT QUANTUM UVIS 3**

The Infrared Spectra of Four Isotopes in HCl: A molecular structure experiment

Richards, L. W.

J. Chem. Educ. 43,552 (1966)

Pt, D, Cl-35, Cl-37 in HCl. Spectra analyzed by computer program, avail.

from author. Cary 14, 2.35-2.55 micron.

***PHYS COMPUTER MOL.SPECT PREP QUANTUM UVIS 3**

The Infrared Spectra of C2H2 and C2D2

Richards, L. W.

J. Chem. Educ. 43,644 (1966)

Preparation and molecular spectroscopy. Theoretical background. Cary 14, 1.5-2.0 microns.

***PHYS APPARATUS DEMO OPTICAL UVIS 2**

A Vidicon Detection System for Teaching Absorption Spectroscopy

Richtol, H. H.; Nelson, D. L.; Reeves, R. R., Jr.

J. Chem. Educ. 52,218 (1975)

Describes conversion of a TV set to a spectrograph for viewing by large audiences.

***PHYS ANAL APPARATUS DEMO OPTICAL QUANTUM UVIS 2**

Converting a Television System into a Quantitative Atomic Emission Spectrograph.

Richtol, H. H.; Reeves, R. R.; Nelson, D. L.

J. Chem. Educ. 52,198 (1975)

Conversion by placing a transmission grating on the lens of a TV camera focussed on a discharge tube.

***PHYS KSP SOLUB THERMO 2**

Thermodynamics and Solubilities of Salts of Dipositive Ions

Riley, G. F.; Eberhardt, W. H.

J. Chem. Educ. 56,206 (1979)

Chlorides, sulfates, carbonates, and hydroxides of Ba, Ca, Mg, Cu, Pb, Zn.

Student calculates solubility from free-energy of formation at 0.1M tables (pre-lab) and then checks results in lab.

***PHYS DEMO FLUOR MICELLE 2**

Enhancement of Concentration Quenching by Micelles

Roessler, N.

J. Chem. Educ. 56,675 (1979)

Fluorescence of the dianion in solutions of the sodium salt of fluorescein is quenched by cetyltrimethylammonium bromide above the critical micelle concentration.

***PHYS ORG APPARATUS CALORIMETRY THERMO 4**

Heats of Hydrogenation: A physical-organic laboratory experiment

Rogers, D. W.; McLafferty, F. J.

J. Chem. Educ. 48,548 (1971)

Reaction chamber of a new safer calorimeter described. Thermistor, bridge and galvanometer. Hydrogen at 80 cm Hg above atmosphere. Palladium black catalyst. Results given for cyclohexene, 1,7-octadiene, etc.

***PHYS APPARATUS CATAL GC KIN PROJ 4**

Laboratory Research in Catalysis: Coordinating undergraduate analytical, organic, and physical chemistry

Rondini, J.; Feighan, J. A.; Downey, B. J.

J. Chem. Educ. 52,129 (1975)

Silica-alumina cracking catalysts, modified by metal acetylacetonate impregnation and pyrolysis, used to study rate and products of cumene catalytic pyrolysis. Temperature and catalyst varied. Used as six-week senior project.

***PHYS COMPUTER DRYLAB KIN 4 5**

Simulation of Experimental Data, the Design of Experiments, and the Analysis of Results: Kinetics of Catalyzed Ester Hydrolysis
Rosenthal, D.; Arnold, D.

J. Chem. Educ. 54,323 (1977)

The student is presented by the computer with a large array of information on the hydrolysis of p-methylphenyl formate, and is asked to design experiments to answer questions such as "Is there evidence for H⁺-catalyzed reactions?", etc. Suitable for graduate students. Kinetics simulation program (KESIP) available.

***PHYS ANAL ACBA ELECTROANAL KEQ PH TITN 3 4**

A Conductimetric-Potentiometric Titration for an Advanced Laboratory
Rosenthal, L. C.; Nathan, L. C.

J. Chem. Educ. 58,656 (1981)

Simultaneous determination of conductivity and pH curves for titration of glycine hydrochloride with NaOH. Calculation of the two glycine acid dissociation constants and molar conductivities of protonated glycine and glycinate anion.

***PHYS EXCHANGE GAS ISOTOPE KEQ STATISTICS VACTEK 4**

The DCI-HBr Isotope Exchange Equilibrium: A statistical and experimental exercise for the physical chemistry laboratory

Ruark, J. E.; Ivers, J. I.; Roberts, J. L.

J. Chem. Educ. 51,758 (1974)

Exp. conf. of a statistically predicted eq. const. Uses Cary Model 14 spectrophotometer, gas cell. Discusses theory.

***PHYS GAS KIN MASSPEC VACTEK 3**

The Thermal Decomposition of 2,5-Dihydrofuran Vapor

Rubin, J. A.; Filseth, S. V.

J. Chem. Educ. 46,57 (1969)

Dihydrofuran decomposes at 300-400 C to furan and hydrogen. Rate by pressure change. Activation energy by rate variance with temp. Optional mass spectral product analysis.

***PHYS CATAL COMPLEX DEMO KIN 1 2**

A Versatile Kinetics Demonstration

Ruda, P. T.

J. Chem. Educ. 55,652 (1978)

Oxidation of tartaric acid by 6% H₂O₂ in the presence of cobalt chloride catalyst. Complex formation; interpretation as "activated complex" is questionable.

***PHYS APPARATUS CRYSTAL XRAY 4**

Laboratory Experiments in Low-Temperature X-Ray Diffraction

Rudman, R.

J. Chem. Educ. 44,331 (1967)

Debye-Scherrer diffraction of t-butyl chloride, cyclooctanone, urea at temperatures to -140 deg. C. Interpretation from other ref.

***PHYS APPARATUS DIFFUSION KIN MEMBRANE 3**

Transport of Caffeine Through Millipore Filter

Rujimethabhas, M.; Crossley, J.

J. Chem. Educ. 59,876 (1982)

Easily constructed diffusion apparatus is used; samples are withdrawn during 90 min. The diffusion rate is obtained by UV measurement of caffeine conc. in dil. solution, and application of equations. The theory is developed.

***PHYS COLLOID FLUOR MICELLE UVIS 3**

Determination of Critical Micelle Concentration Using Acridine Orange Dye Probe

Rujimethabhas, M.; Wilairat, P.

J. Chem. Educ. 55,342 (1978)

In or near region of CMC of sodium dodecyl sulfate, there is a sharp change in fluorescence and an interpretable change in absorbance of the solution.

***PHYS DEMO 4 5**

Imposed Orientation of Dye Molecules by Liquid Crystals and an Electric Field

Sadlej-Sosnowska, N.

J. Chem. Educ. 57,223 (1980)

Change in color of dye in liquid crystal in response to electric signal explains visual displays used in watches and calculators. Could be good lower-level demo.

***PHYS KIN PROJ 4**

Non-Isothermic Chemical Kinetics in the Undergraduate Laboratory

Arrhenius Parameters from Experiments with Hyperbolic Temp. Variation

Salvador, F.; Gonzalez, J. L.; Tel, L. M.

J. Chem. Educ. 61,921 (1984)

A novel method of determining Arrhenius factors for reactions following known rate laws involves hyperbolic variation of temperature.

The theory and method are described, though not in detail. Applications are suggested, not described. Would require much work to implement.

***PHYS APPARATUS GAS VACTEK VISC 3**

A Simple Gas Viscosity Experiment

Salzberg, H. W.

J. Chem. Educ. 42,663 (1965)

Viscosities of common lab gases measured by flow thru capillary on vac line apparatus; ideal gas law; Poiseuille's eqn; pressure measurement.

***PHYS FREERAD HITEMP KIN VACTEK 4**

Demonstrating Self-Acceleration or Self-Inhibition Phenomena in Chemical Reactions: An experiment in alkane pyrolysis

Scacchi, G.; Foucaut, J. F.; Niclause, M.

J. Chem. Educ. 57,748 (1980)

Pyrolysis of neopentane (20-350 torr., 500 deg.C) followed by pressure measurements. Comparison of initial rxn. order (3/2) with instantaneous order at $t > 0$ shows rxn. is self-inhibited by product isobutene. Mechanism discussed.

***PHYS CHIRAL ORD UVIS 4 HAZARD**

An Experiment in Optical Rotatory Dispersion

Scholz, J. P.; Purdy, W. C.

J. Chem. Educ. 41,645 (1964)

Optical rotary dispersion accessory with recording ultraviolet spec. Sol'ns of androsterone in dioxane prepared at various concentrations for calibration curve. HAZARD: dioxane - carcinogen

***PHYS POLYMER DEMO THERMO 2**

Demonstration Tests

Schulbach, C. D.; Ahmed, I. Y.

J. Chem. Educ. 53,775 (1976)

Tests (exams) in lecture utilize demos performed during exams as scenarios for exam questions. Illustrated with then familiar "thermodynamics of a rubber band". A tested demonstration.

***PHYS BIOCHEM KIN UVIS 3**

The Hydrolysis of p-Nitrophenyl Beta-Glucoside: An undergraduate experiment

Schram, A. C.

J. Chem. Educ. 56,351 (1979)

Basic hydrolysis from colorless glucoside to intensely colored p-nitrophenolate ion followed spectrophotometrically. Concentration and temperature dependence measured. Caution: 5N NaOH causes skin burns.

***PHYS ORG ACBA KIN TITN 3 HAZARD**

Determining a Reaction Rate Constant: An organic laboratory experiment

Schreck, J. O.

J. Chem. Educ. 43,149 (1966)

Reaction of methyl iodide and potassium t-butoxide followed by removal of aliquots for analysis by acid-base titration. HAZARD: HClO_4 is a storage and disposal hazard. Suggest use HCl.

***PHYS ORG ACBA KIN 3**

An Example of Following Second-Order Kinetics by Simple Laboratory Means

Schreiber, G.

J. Chem. Educ. 53,664 (1976)

Hydrolysis of ethylene bromohydrin ($\text{BrCH}_2\text{CH}_2\text{OH}$) in alkaline medium. A fixed conc. of hydroxide is used with varied but large excess conc. of the bromohydrin together with an acid base indicator. The time measured to the color change is used to follow the reaction. No proof that it is second order, but only it is first order in bromohydrin.

***PHYS ASSOC COLLIG OSMOSIS VAPORPRESS 3 HAZARD**

Intermolecular Association by Vapor Pressure Osmometry

Schrier, E. E.

J. Chem. Educ. 45,176 (1968)

Caprolactam and N-butylacetamide have different patterns of H-bonding. Measurement of vapor pressures of dilute solutions allows calculation of association constants and schemes (discussed). HAZARD: benzene, solvent, is carcinogen.

***PHYS ASSOC DENSITY DIPOLE 3**

Intermolecular Association and Molar Polarization: Physical chemistry experiment

Schrier, E. E.

J. Chem. Educ. 43,257 (1966)

Dielectric constant and density measured, used to calculate molar polarizations at various concentrations. Changes with concentration for caprolactam and N-methylacetamide differ because of different association patterns.

***PHYS APPARATUS THERMO 3**

Measuring the Ratio of Specific Heats of a Gas: Thermodynamic Experiments Involving Harmonic Motion

Schulfe, J. A.

J. Chem. Educ. 34,78 (1957)

Method 1 uses oscillation time when a piston drops in a closed tube of gas. Method 2 uses audio oscillator and tube with movable piston to get standing acoustic waves, with nodes visualized by powder. Theory developed.

***PHYS FLUOR PHOSPHOR QUANTUM UVIS 4**

Room Temperature Phosphorescence: An Experiment for the Undergraduate Physical or Analytical Laboratory

Schulman, E. M.

J. Chem. Educ. 53,522 (1976)

Phosphorescence of various materials on rigorously dried filter paper, using room temperature spectrophosphorimeter. Excitation and emission spectra for 16 phosphors given. Delayed fluorescence, singlet-triplet splitting in relation to charge.

***PHYS APPARATUS MOL.SPECT VACTEK 4**

Microwave Spectroscopy in the Undergraduate Laboratory

Schwendeman, R. H.; Volltrauer, H. N.; Laurie, V. W.; Thomas, E. C.
J. Chem. Educ. 47,526 (1970)

Apparatus construction (difficult), experiments on OCS structure, dipole moment of OCS, SO₂, variation of linewidth with pressure, temperature, and vibrational states.

***PHYS THERMO 1 2**

The Experimental Determination of the Heat of Vaporization of Volatile Liquids

Sears, J.; Rickel, R.; Mac, M.; Chames, F.; Farver, N.; Grieve, C.
J. Chem. Educ. 57,362 (1980)

Very simple apparatus described for measuring time required for small vol. of liquid to evaporate at several temps. Heat of vaporization determined from slope of Arrhenius plot. Suitable for demonstration. Caution: choose nontoxic liquids.

***PHYS ELECTROCHEM THERMO 3**

Entropy of Mixing - An Electrochemical Measurement

Selley, N. J.

J. Chem. Educ. 49,212 (1972)

Cell potentials for hexacyanoferrates (II and III) at varying conc. ratios, plotted against ratio. Area under curve is work of mixing.

***PHYS COMPUTER NMR QUANTUM 4**

Calculation of Complex NMR Spectra in the Undergraduate Laboratory

Seyse, R. J.; Pearce, H. L.; Rose, T. L.

J. Chem. Educ. 52,194 (1975)

Tetraethyltin. Varian HA-100 NMR. Experimental and calculated (by LCAON3) spectra.

***PHYS ANAL ORG MICELLE UVIS 2 3**

Absorption Spectroscopy in Homogeneous and Micellar Solutions

Shah, S. S.; Henscheid, L. G.

J. Chem. Educ. 60,685 (1983)

Visible absorption of a merocyanine dye in pyridine, ethanol and aq. sol'n of SDS is investigated. Changes in wave length of max. abs. plotted as a function of solvent polarity provides info on the mode of solubilization of the dye molecules. Synthesis of the dye and a spectrophotometer required.

***PHYS ORG DEMO 0 1**

"Cool-Light" Chemiluminescence

Shakhashiri, B. Z.; Williams, L. G.; Dirreen, G. E.; Francis, A.
J. Chem. Educ. 58,70 (1981)

Effect of temperature on intensity of Cyalume lightsticks. A Tested Demo.

***PHYS APPARATUS GC PHASE VACTEK 3 HAZARD**

Liquid-Vapor Equilibrium at Constant Temperature

Shearer, E. C.

J. Chem. Educ. 50,446 (1973)

Simple equipment: vacuum pump, mercury manometer, sample vessel and gas sampling. Systems studied include acetone-ether, acetone-chloroform; GC used to analyze both vapor and liquid composition rather than refr. index. Several liquid pairs suggested. HAZARD: CHCl₃ is a suspected carcinogen.

***PHYS DENSITY PROJ REFRACT VISC 3**

Physical Properties of Primary Alcohols: An experience in physical chemistry

Shearer, E. C.; Rumpel, M. L.

J. Chem. Educ. 51,140 (1974)

Measurements of a series of primary alcohols teaches techniques and permits some correlation of properties. But not very interesting?

***PHYS ORG KIN PREP UVIS 3**

Hydrolysis of Benzenediazonium Ion: An experiment in first-order kinetics

Sheats, J. E.; Harbison, K. G.

J. Chem. Educ. 47,779 (1970)

Rate of decomposition of benzenediazonium fluoroborate (prepared, stable) by quenching via coupling unreacted ion with 2-naphthol-3,6-disulfonic acid (disodium salt) giving an orange azo compound, max. abs. 490 nm.

***PHYS APPARATUS CALORIMETRY CRYO STATISTICS THERMO VACTEK 4**

The Heat Capacity of Metals: A physical chemistry experiment
Shigeishi, R. A.
J. Chem. Educ. 56, 59 (1979)
Statistical mechanics discussed. 3rd year Honors course, 3 periods.
77-300 K. Einstein and Debye theories. Emphasis is on the apparatus.

***PHYS CLOCK KIN REDOX 3**

The Kinetics of an Ionic Reaction: A physical chemistry experiment
Shurvell, H. F.
J. Chem. Educ. 44, 577 (1967)
Oxidation of iodide by H_2O_2 in acid sol'n. Rates measured by internal aliquots of std. thiosulfate starch. (Iodine-clock).

***PHYS CLOCK KIN 3**

The Activation Energy of an Ionic Reaction: A physical chemistry experiment
Shurvell, H. F.
J. Chem. Educ. 43, 555 (1966)
Iodine-clock modified to give activation energy by rates at different temperatures.

***PHYS CALORIMETRY PROJ 1 2**

A Laboratory Learning Cycle: Hot Stuff
Silberman, R. G.
J. Chem. Educ. 59, 229 (1982)
A problem is posed whose solution involves weighing and mixing hot and cold liquids. It is not intended for students to read this experiment.

***PHYS GAS VAPORPRESS 2**

A Pseudo-Charles' Law Experiment to Teach Vapor Pressure Concepts
Sinclair, D. L.
J. Chem. Educ. 46, 814 (1969)
Using water as a confining liquid for air in a Charles' law experiment gives misleading results - for students to explain.

***PHYS DEMO KIN SOLUB 1**

Effect of Temperature on Reaction Rate.
Siwon, J.
J. Chem. Educ. 49, A85 (1972)
Rate of solution of aluminum in 10M HCl increased as temp. increases.
A Chem. Ed. Tested Demo.

***PHYS AVOGADRO COLLOID MICROSCOPE 3**

Determination of Avogadro's Number by Perrin's Law
Slabaugh, W. H.
J. Chem. Educ. 42, 471 (1965)
Perrin's method. Gum Gamboge; centrifuge at 1500 rpm to monodisperse suspension. Slide prep'n and observation on vertical stage of microscope; uses a calibrated-grid reticle for counting particles. Two-week exp't.

***PHYS AVOGADRO REVIEW 2**

Avogadro's Number by Four Methods
Slabaugh, W. H.
J. Chem. Educ. 46, 40 (1969)
Particle distribution in gamboge suspension (Perrin); electroplating Cu and Ag, oleic acid monolayer on water, electrolysis of water compared.

***PHYS APPARATUS GAS NOPROC PHOTO VACTEK 4**

Determination of Molecular Diameters by the Use of the Crookes Radiometer: An undergraduate experiment
Smith, J. H.
J. Chem. Educ. 47, 590 (1970)
Uses toy radiometer (or one constructed), vac. manifold. Pirani gauge, ir lamp; complicated kinetic theory of gases.

***PHYS APPARATUS ELECTROCHEM KIN NOPROC 4**

A Kinetic Experiment Using Potentiometric Determination of Reactant Concentration
Smith, R. H.
J. Chem. Educ. 50, 441 (1973)
Oxidation of formate and oxalate with bromine followed potentiometrically (Br_2/Br^- redox). 6-9 hrs lab time or project.

***PHYS ACBA CALORIMETRY KEQ THERMO TITN 3**

The Thermodynamics of Ionization of the Bisulfate Ion: A physical chemistry laboratory experiment
Smith, R. L.; Pinnick, Jr., H. R.
J. Chem. Educ. 57, 154 (1980)
Commercial titration calorimeter used to determine pK_a , and enthalpy and entropy changes for protonation of sulfate ion in dilute aqueous sol'n. Published FORTRAN program (ref. 2) used for data reductions. Neither apparatus nor data analysis discussed.

***PHYS ACBA CALORIMETRY KEQ THERMO TITN 3**

The Heat of Protonation of Pyridine and Chloro Substituted Pyridines:

A physical chemistry laboratory experiment

Smith, R. L.; Pinnick, Jr., H. R.

J. Chem. Educ. 57,320 (1980)

Commercial titration calorimeter used to determine enthalpy and entropy changes for protonation of pyridine and 2- and 3-chloropyridine in aqueous sol'n. Published FORTRAN program (ref. 2) used for data reduction. Neither apparatus nor data analysis discussed. Caution: pyridines, poisons.

***PHYS DEMO SOLUB 2 HAZARD**

Selective Solubility: "Like Dissolves Like"

Smith, W. L.

J. Chem. Educ. 54,228 (1977)

Azobenzene dissolves in CCl₄ (but not in water) to give a bright orange solution. Simple. A tested demonstration. HAZARD: CCl₄ (carcinogen).

***PHYS ORG KEQ KIN NMR 5**

Kinetic Study by NMR

Socrates, G.

J. Chem. Educ. 44,575 (1967)

Hydration of pyruvic acid, equilibrium first measured by NMR integ. Kinetics by line broadening.

***PHYS VISC 2**

Liquid Viscosity Measurement Using a Buret: An instructional technique

Sorrell, C. A.

J. Chem. Educ. 48,252 (1971)

Simple method for measuring viscosities of relatively low viscosity liquids such as water, acetone, etc. Requires calibration with several known liquids, and good temperature control is very difficult.

***PHYS ANAL INORG COLOR PROJ SOLAR UVIS 1 2**

Chemical Storage of Solar Energy Using an Old Color Change Demonstration

Spears, L. G., Jr.; Spears, L. G.

J. Chem. Educ. 61,252 (1984)

Use of aq. isopropyl alcohol soln. of CoCl₂·6H₂O as a solar energy collector is investigated. Co(H₂O)₆·2 + 4Cl⁻ = CoCl₄·2 + 6H₂O is endothermic. Exptl. work includes solubility, colorimetric detn. of equilib., effect of Cl⁻, specific heat, and heat of hydration. Student cup calorimeters are adequate.

***PHYS ORG IR KEQ 4 HAZARD**

Spectrophotometric Determination of an Equilibrium Constant

Spencer, J. N.

J. Chem. Educ. 50,298 (1973)

H-Bonding of methanol-ether in CCl₄ measured 2650-2950 nm. Recording spectrophotometer. HAZARD: CCl₄ is a carcinogen, can be avoided.

***PHYS ORG NMR 4**

CINDP Experiment Using a Permanent Magnet NMR

Spencer, T. S.; O'Donnell, C. M.

J. Chem. Educ. 50,152 (1973)

Nuclear Overhauser effect. NMR spectra of free radicals formed from n-butyllithium with 2-iodopropane.

***PHYS THERMO UVIS 4**

Heat of Vaporization of Iodine Using Absolute Entropy Data: A physical chemistry experiment

Stafford, F. E.

J. Chem. Educ. 40,249 (1963)

Iodine crystals placed in 10-cm absorption cell and allowed to equilibrate at various temp. Beer's Law plot. Combined Keq and third law tabulated (and calculated) delta-S gives delta-H.

***PHYS COMPUTER MOL.SPECT UVIS 4**

Band Spectra and Dissociation Energies: A physical chemistry experiment

Stafford, F. E.

J. Chem. Educ. 39,626 (1962)

Visible spectra of gaseous Br₂, I₂ recorded (1 period). Complicated calculations (computer program available) give dissociation energies, vibrational levels. Two to three periods for calc.

***PHYS IR MOL.SPECT QUANTUM 4**

Vibration-Rotation Spectrum of HCl: A physical chemistry experiment

Stafford, F. E.; Holt, C. W.; Paulson, G. L.

J. Chem. Educ. 40,245 (1963)

Much theory discussion and help in interpreting data. Cary 14.

***PHYS MOL.SPECT UVIS 3**

Atomic Spectra: A physical chemistry experiment

Stafford, F. E.; Wortman, J. H.

J. Chem. Educ. 39,630 (1962)

Sodium (best), potassium, or hydrogen spectrum recorded Cary Model II, analyzed for sharp, principal and diffuse spectra series limits and ionization potentials.

***PHYS ORG LIQUID PROJ VAPORPRESS 1**

Raoult's Law: A General Chemistry Experiment

Steffel, M. J.

J. Chem. Educ. 60,500 (1983)

Implicit procedure. Direction of deviations from Raoult's Law for 19 non-carcinogenic liquid pairs listed; use of molecular models in conjunction w. experimental work suggested. Hg manometer.

***PHYS FLUOR MOL.SPECT 4**

A Molecular Fluorescence Experiment for undergraduate physical chemistry

Steinfeld, J. I.

J. Chem. Educ. 42,85 (1965)

Quartz mercury arc, spectrograph, film recording. Iodine fluorescence; std. neon spectrum. See also Tellinghuisen, J., J. Chem. Ed., 58, 438 (1981).

***PHYS ANAL INORG BIOCHEM COURSE NOPROC PROJ RADIOCHEM 2**

A Chemistry Projects Laboratory

Steinfeld, J. I.

J. Chem. Educ. 46,232 (1969)

Project used at MIT in place of required general chemistry lab includes many different techniques.

***PHYS ACBA KEQ PH TITN 2**

Determination of pKa Using the Half-Volume Method: A Laboratory Method

Stephens, S. J.; Joncich, M. J.

J. Chem. Educ. 54,711 (1977)

Classical method for simultaneous titrimetric determination of pKa and m.wt. of weak monoprotic acids. ("Method of half-neutralization").

***PHYS CALORIMETRY THERMO 4 HAZARD**

The Determination of the Resonance Energy of Benzene: A physical chemistry laboratory experiment

Stevenson, G. R.

J. Chem. Educ. 49,781 (1972)

Parr oxygen-bomb calorimeter. This is the now classic experiment included in many courses where the resonance energy of benzene is calculated from the heats of combustion of benzene and cyclooctatetraene. Hazard: benzene is a carcinogen.

***PHYS ANAL APPARATUS ELECTROANAL KIN 3**

A Simple Low-Current Potentiostat Coulometric Analysis: The Hydrolysis of Benzoyl Chloride

Stock, J. T.

J. Chem. Educ. 45,736 (1968)

Circuit diagrams for potentiostat and power supply. Coulometric analysis for 2,2-dinitropropane given in detail.

***PHYS APPARATUS ELECTROCHEM KIN 3**

A Stabilized Direct-Reading Conductance Apparatus

Stock, J. T.

J. Chem. Educ. 44,573 (1967)

Circuit diagram and details of micro cell construction. Use for measuring rate of hydrolysis of benzoyl chloride. Kinetics at two temperatures gives activation energy.

***PHYS APPARATUS FASTREACTION FLASHPHOTOL KIN 4**

Direct Studies of Atomic Reactions in the Undergraduate Laboratory:

Time Resolved Atomic Absorption Spectroscopy

Stock, M. G.; Little, D. J.; Donovan, R. J.

J. Chem. Educ. 51,51 (1974)

Apparatus described for flash photolysis of methyl iodide to yield iodine atoms in the first excited state. Decay of this state followed on oscilloscope. Decay is first order in I.

***PHYS ORG KIN PHARM UVIS 2 3**

The Hydroxylaminolysis of Penicillin G: A kinetic experiment

Stuckwisch, C. G.

J. Chem. Educ. 49,539 (1972)

Penicillin reacts with hydroxylamine to yield a hydroxamic acid. This gives a colored complex with Fe+3; reaction can be followed spectrophotometrically

***PHYS ORG HEAT KIN NMR 3**

Solution Pyrolysis Kinetics Utilizing NMR Spectra

Stump, B. L.; Ottenbrite, R. M.; Brockington, J. W.

J. Chem. Educ. 53,257 (1976)

Decomp. of 1,1-diphenylpropyl hydrogen phthalate in DMSO is 1st order and can be followed by nmr techniques. Determinations at 65, 75, 80 and 92 degrees C, by nmr after quenching. Straightforward. Extensions to synthesis suggested.

***PHYS APPARATUS BIOCHEM DENSITY THERMO 4**

The Determination of Partial Specific Volume: A physical chemistry experiment

Sun, S. F.; Serpentino, P. M.

J. Chem. Educ. 51,552 (1974)

Crystalline bovine serum is dissolved in 0.1M KCl. Special pycnometers. Simple, accurate method gives data suitable for molecular weight det'n.

***PHYS APPARATUS DENSITY GAS 3**

Semi-Micro Vapor Density Apparatus

Svec, H. J.; Peterson, N. C.

J. Chem. Educ. 42,336 (1965)

Simple glass apparatus and technique, using 15 microliters.

Requires glass-blowing.

***PHYS KIN OSC.RXN 4**

Oscillations in the Iodate-Mn++ System: Apparent Energy of Activation

Swamy, C. S.; Doss, K. S. G.

J. Chem. Educ. 56,321 (1979)

Monitor frequency of oscillation by color change or oscillation of pH meter. Plot of $-\log t$ vs $1/T$ is a straight line.

***PHYS COMPUTER STATISTICS TECHNIQUE 4**

Determination of the Nyquist Frequency: A computer-interfacing experiment

Swanson, R.; Thoennes, D. J.; Williams, R. C.; Wilkins, C. L.

J. Chem. Educ. 52,530 (1975)

Expt'l. illustrates parameters in analog to digital conversions of meaningful data. Sampling theory. Requires real-time BASIC, digital to analog converter, computer controlled clock, analog to digital converter.

***PHYS KIN TECHNIQUE 4**

Relaxation Kinetics: An experiment for physical chemistry

Swinehart, J. H.

J. Chem. Educ. 44,524 (1967)

Study of chromate-dichromate equilibrium by mixing small amounts of conc. CrO_4^{2-} - $\text{Cr}_2\text{O}_7^{2-}$ solution into larger volume of a more dilute solution containing an indicator. pH change resulting from perturbation monitored spectrophotometrically at indicator absorption maximum.

***PHYS AVOGADRO ELECTROANAL GAS 1 2**

An Approximate Determination of Avogadro's Constant

Szell, T.; Dennis, D.; Jouas, J. P.; Wong, M.

J. Chem. Educ. 57,735 (1980)

Vol. of hydrogen gas liberated by electrolysis of dilute sulfuric acid sol'n used to calculate Avogadro's number. Simple apparatus for gas collection and coulomb measurements described. Commercial source cited. Authors claim less than 5% error. It has been done before.

***PHYS ORG KIN TITN 4**

A Second Order Kinetics Experiment

Teerlink, W. J.; Asay, J.; Sugihara, J. M.

J. Chem. Educ. 41,161 (1964)

Samples of NaI and ethyl p-toluenesulfonate reacted at const. temp. At intervals, reaction is quenched and titrated with AgNO_3 -eosin. Data plotted to yield 2nd order rate constant.

***PHYS DRYLAB FLUOR 3 4**

Laser-Induced Molecular Fluorescence: A physical chemistry experiment

Tellinghuisen, J.

J. Chem. Educ. 58,438 (1981)

Iodine fluorescence spectrum may be recorded quickly by laser Raman rather than photographic recording. Much detail on analysis. Intended to be run as drylab.

***PHYS ACBA ASSOC DISTRIB ENVIRON IONX KEQ THERMO 2 3**

Use of a pH Difference to Pump an Anion across a Non-aqueous Phase

Thelander, P. F.; Hasledalen, L. A.; Kreevoy, M. M.

J. Chem. Educ. 57,509 (1980)

Expt. designed to show that: 1) work required to transfer a species from one solution to another depends on concs., and 2) irreversible work greater than reversible work. Anion is Orange II, conc. measured with spectrophotometer. Non-aqueous phase is dilute sol'n of didodecylamine in tetrachloroethylene. Applications of "liquid ion exchange" to resource recovery discussed.

CAUTION: tetrachloroethylene is a cancer suspect agent.

***PHYS DEMO ELECTROCHEM 2**

Electrolytic Conductivity: A Demonstration Experiment

Thomas, W. B.

J. Chem. Educ. 39, 531 (1962)

Ohm's Law approach. Circuit incorporates vacuum tube voltmeter, milliammeter. Results given for 12 test solutions.

***PHYS COLLOID UVIS 4**

A Light Scattering Experiment for Physical Chemistry

Thompson, A. C.; Kozimer, K. G.; Stockwell, D. G.

J. Chem. Educ. 47, 828 (1970)

Light-scattering experiments with commercial colloidal silica sols.

Turbidity measurements at different wavelengths allow det'n of particle diameters.

***PHYS ELECTROCHEM 1**

Charge and Mass of the Electron: An introductory experiment

Thompson, C. C.

J. Chem. Educ. 50, 435 (1973)

Obs. of time, current, weight change at electrodes in Cu, Pb or Ni

coulometers allows calc'n of charge of an Avogadro number of electrons.

Mass is from e:m ratio, given, not determined.

***PHYS ORG PHOTO UVIS 3 HAZARD**

Photo-Oxidation of Leuco Methyl Crystal Violet: A physical chemistry experiment

Thyriou, F. C.

J. Chem. Educ. 48, 766 (1971)

LCMV sol'n in ethanol irradiated at 590 nm. with and without CCl₄ sensitizer. HAZARD: CCl₄ and asbestos sheeting (around light source) are carcinogens; protect eyes from UV radiation. Requires double beam spectrophotometer. Extensions.

***PHYS ORG ELECTROCHEM KIN NOPROC 3**

Determining Second Order Rate Constants

Tobey, S. W.

J. Chem. Educ. 39, 473 (1962)

Alkaline hydrolysis of phenyl m-nitrobenzoate by a conductimetric technique.

Original (by the authors, not otherwise described, in journal literature) treatment of data.

***PHYS ANAL ACBA INSTR KEQ MOLSPECT PH 3**

The Acid Dissociation Constant of Methyl Red: A spectrophotometric measurement

Tobey, S. W.

J. Chem. Educ. 35, 514 (1958)

Beckman B spectrophotometer, pH meter. Straightforward.

***PHYS APPARATUS PHASE VAPORPRESS 3 HAZARD**

Ideal Solution Laws: Apparatus and experiment

Tobey, S. W.

J. Chem. Educ. 39, 258 (1962)

Raoult's law proved. Apparatus requires some glassblowing. Organic liquid mixtures heated under slight pressure presents a flammability HAZARD.

***PHYS DRYLAB MASSPEC SIMULATION 2**

A Microprocessor-Simulated Mass Spectrometer

Traeger, J. C.

J. Chem. Educ. 58, 411 (1981)

Home-brew microcomputer used to generate a mass spectrum; stored in EPROM memory chips. Student to identify and compare with library of spectra.

Sophisticated electronic construction from purchased components.

***PHYS ACBA COMPUTER THERMO TITN UVIS 4**

Thermodynamic Analysis of a Coupled Chemical Reaction

Trimm, H.; Patel, R. C.; Ushio, H.

J. Chem. Educ. 56, 762 (1979)

Theory discussed, not easy. Procedure in detail. Curve-fitting; dedicated microcomputer. This reaction req. titration of phenol red in buffer (both compete for H⁺).

***PHYS APPARATUS KIN 3**

A Simple Apparatus for Gas Reactions: The decomposition of di-t-butyl peroxide

Trotman-Dickenson, A. F.

J. Chem. Educ. 46, 396 (1969)

Reaction in a stoppered flask filled with inert gas, with an internal Bourdon gauge pressure transducer.

***PHYS COORD KIN 2**

Aquation of Tris-(1,10-phenanthroline) Iron(II) in Acid Solution: A kinetics experiment

Twigg, M. V.

J. Chem. Educ. 49,371 (1972)

Rate of decay of color of ferrous-phenanthroline complex in dilute mineral acids followed at 510 nm. First order. Temperature dependence gives activation energy.

***PHYS SOLUB 1 2**

Equilibrium or Slow Change?—An Experiment for the General Chemistry Laboratory

Umland, J. P.; Fefer, J. A.

J. Chem. Educ. 60,59 (1983)

Saturated solutions of potassium chloride are prepared (a) by mixing an excess of the solid in water at a fixed temperature and (b) by cooling a concentrated solution (prepared by reacting K_2CO_3 with hydrochloric acid) to that temperature. The concentrations of the "saturated" solutions are analyzed by evaporation and weighing.

***PHYS COMPLEX ELECTROCHEM KSP 3**

Potentiometric Determination of the "Operational" Ksp of $Ag(CN)_2Ag$

Ungerer, B.; Jurio, R.; Manuele, R. J.

J. Chem. Educ. 49,434 (1972)

Silver ion titration in KI, KCN forms $Ag(CN)_2$ ion, then AgI precipitate, finally $Ag(CN)_2Ag$.

***PHYS ORG NMR TECHNIQUE 4**

Experimental Determination of the Nuclear Overhauser Effect

VanAntwerp, C. L.

J. Chem. Educ. 50,638 (1973)

NOE enhancement measurement. Varian T-60, vacuum line. 3,3-dimethylacrylic acid, TMS, low magnetic solvent, etc.

***PHYS ELECTROCHEM 2**

Coulometry: A series experiment

VanLente, K. A.

J. Chem. Educ. 43,306 (1966)

Comparison between a silver coulometer, an iodine, and a gas coulometer.

***PHYS ORG CRYSTAL ELECTROOPTIC INTEGR LIQUID.CRYSTAL MICROSCOPE PREF**

Liquid Crystals - Synthesis and Properties: An experiment for the integrated organic and physical laboratory

Verbit, L.

J. Chem. Educ. 49,36 (1972)

Explicit directions for prep'n of cholesterol benzoate and p-methoxy-benzylidene p-N-butylaniline. Two optical exp'ts, use polarizing microscope and conducting glass.

***PHYS ORG KIN PHOTO UVIS 3**

An Experiment to Determine a Photochemical Quantum Yield

Vernon, A. A.; Forbes, G. S.

J. Chem. Educ. 34,350 (1957)

Comparison of the rates of photolysis of malonic and oxalic acids. An oxalic acid-uranyl ion solution is used as the actinometer. 45 minute exposure to 8-watt germicidal lamp. Permanganate titrations. Caution: uranium compounds are radioactive.

***PHYS ELECTROCHEM ELECTRODE THERMO 3**

Thermodynamic Parameters From an Electrochemical Cell

Vincent, C. A.

J. Chem. Educ. 47,365 (1970)

Prep'n of a calomel electrode given explicitly, and prep'n of $Ag-AgCl$ electrodes described. This cell allows measurement of temp. coefficient of emf.

***PHYS ORG DEMO PHASE 1 2 HAZARD**

Organic Eutectic Mixtures

Viswanathan, A.

J. Chem. Educ. 37, A36 (1960)

A Chem-Ed Tested Demo. Four pairs of compounds, solid at room temp. melt on being mixed together, with a lowering of the temperature.

HAZARD: some of the organics listed are now known to be carcinogens (such as alpha-naphthylamine). The author suggests that other pairs can found on p. 177 of the International Critical Tables, Volume 4 (1928).

***PHYS CRYO 2**

Salt Cryoscopy

Wale, C. L.

J. Chem. Educ. 48,539 (1971)

A better version of the "lowering of the freezing point" experiment than is usual in most Gen. Chem. Labs. Uses thick-walled vessel, semimicro Beckmann thermometer or thermistor, thermostat, rapid stirring device. Expt is to find mwt of an unknown by depression of transition point of Na_2SO_4 .

***PHYS APPARATUS COLLIG GLOBE 5**

Determination of the Molecular Weight of Air-Sensitive Compounds
Walker, F. W.; Ashby, E. C.
J. Chem. Educ. 45, 654 (1968)
Apparatus and procedure for mol. wt. by boiling pt. elevation under nitrogen. Elaborate apparatus for sensitive compounds, eg. Grignard solutions. Most useful in research.

***PHYS COLORIMETRY COORD KIN REDOX 3**

Ionic Strength Effect on the Rate of Reduction of Hexacyanoferrate(III) by Ascorbic Acid: A physical chemistry laboratory experiment
Watkins, K. W.; Olson, J. A.
J. Chem. Educ. 57, 158 (1980)
Reduction of the Fe(III) species followed spectrophotometrically. Rate law derived from multistep mechanism. Illustrates difference between stoichiometric coefficients and rate law orders, i.e., rate law is first order in Fe(III) species and in ascorbic acid, but stoichiometry is 2:1. Variation of second order rate constant could be extended to include pH effects. Caution: ferricyanide, poison.

***PHYS DIFFUSION 3**

Diffusion in Liquids: A class experiment
Watts, H.
J. Chem. Educ. 39, 477 (1962)
KCl in agar in test tubes with open end in water. Diffusion coefficients calculated from change in KCl conc. (avg.) in gel with time (one week).

***PHYS ESR QUANTUM TECHNIQUE 4**

ESR Studies of Hyperfine Interactions in DMSO-H₂O Solutions: A Physical chemistry experiment
Watts, M. T.; Vanreel, R. E.; Eastman, M. P.
J. Chem. Educ. 50, 287 (1973)
Simple ESR measurements of the 14-N hyperfine splitting of the ditertiarybutyl nitroxide radical in DMSO-H₂O solution, used to confirm strong DMSO-H₂O interactions. DTBN purchased or synthesized (ref.).

***PHYS DEMO ELECTROCHEM MOLTENSALT 1**

Conductivity of Fused Salts
Weaver, E. C.
J. Chem. Educ. 35, A60 (1958)
A Chem-Ed Tested Demo. The fused salt is semi-liquid soft glass.

***PHYS ACBA STOICH TITN 1 2**

An Experimental Introduction to Stoichiometry
Webb, M. J.
J. Chem. Educ. 58, 192 (1981)
Acid-base titrations using medicine droppers and phenolphthalein indicator. Intended as experimental intro. to stoichiometry as complement to study of balanced equations and the mole concept.

***PHYS ANAL ORG CALORIMETRY CATAL KIN 3**

A Thermoanalytical Kinetic Experiment: The Catalyzed Reaction of Phenyl Isocyanate With Butanol
Weisfield, L. B.
J. Chem. Educ. 38, 88 (1961)
Simple equipment. Rate constant graphically from temperature-time plot. Method not useful if heat of solution is comparable to heat of reaction.

***PHYS APPARATUS DTA KIN 3**

Reaction Kinetics by Differential Thermal Analysis
Wendlandt, W. W.
J. Chem. Educ. 38, 571 (1961)
Furnace constructed, also temperature controller, amplifier. All could be purchased. Curves in air and in helium differ because of CO + O₂ yielding CO₂. Kinetics from graphs with approximations. NaHCO₃, CaC₂O₄.H₂O.

***PHYS CHARGETRANS COMPLEX PROJ UVIS 3**

Molecular Charge Transfer Complexes: A group experiment in physical chemistry
Wentworth, W. E.; Drake, G. W.; Hirsch, W.; Chen, E.
J. Chem. Educ. 41, 373 (1964)
Tetracyanoethylene complexes with benzene and methyl benzenes measured (375 - 550 nm) with recording spectrometer. Extensive theory discussion.

***PHYS ANAL EDTA KSP NOPROC SOLUB TITN 3**

The Effects of Chloride Ion and Temperature on Lead Chloride Solubility: A versatile quantitative experiment
West, A. C.
J. Chem. Educ. 46, 773 (1969)
Pb+2 by titr. EDTA with xylenol orange. 3 lab periods

***PHYS APPARATUS GAS KEQ PHOTO THERMO VACTEK 3 HAZARD**

A Photometric Study of the N_2O_4 - NO_2 System: A physical chemistry experiment
Wettack, F. S.

J. Chem. Educ. 49,556 (1972)

Special cell on vac. system, mercury lamp, phototube. Only NO_2 absorbs at 500-600 nm. Pressure and temperature varied. Good pedagogically as brown gas allows student to see results of gas handling by vacuum techniques.

HAZARD: NO_2 is highly toxic.

***PHYS COMPUTER FLUOR PHOTO UVIS VACTEK 4**

Vibronic Energy Transfer: A physical chemistry experiment

Wettack, F. S.; Bibart, C. H.

J. Chem. Educ. 48,126 (1971)

Fluorescence quenching of benzene by added gases. Diagram of vac. and optical systems. Data taken is amps photocurrent vs. pressure. Collision cross-sections calculated. Monochromator, mercury source, photomultiplier, microammeter. Caution: benzene (in vacuum system) is a carcinogen.

***PHYS INORG COORD KIN PREP UVIS 3**

A Kinetics Experiment for the Physical Chemistry Laboratory

Whitaker, R. D.

J. Chem. Educ. 40,264 (1963)

Rate of step-wise diss'n of nickel-o-phenanthroline complex, $\text{Ni}(\text{o-phen})_3$, followed spectrophotometrically at 420 nm and at different temp. Directions for prep'n of complex given.

***PHYS ANAL ACBA KEQ PH TITN 2**

Conjugate Acid-Base Mixtures in the General Chemistry Laboratory:

A comprehensive buffer experiment

Wiger, G. R.; DelaCamp, U. U.

J. Chem. Educ. 55,401 (1978)

Students are led to derive buffer relationships by experiments.

***PHYS ANAL APPARATUS IONSELECT MOLTENSALT 4 HAZARD**

Ion Specific Electrodes in Fused Salts

Wilcox, F., Sr.

J. Chem. Educ. 52,123 (1975)

Prep'n of glass-membrane ion-sel. electrodes and use in various nitrate melts described. Furnace construction given. HAZARD: protect all nitrate melts from contact with carbon-containing compounds. Serious explosive hazard. Refer: Janz & Allen, J. Hazardous Materials, 1981.

***PHYS INORG DEMO PHASE PROJ SOLID 2**

Inorganic Thermochromism: A Lecture Demonstration of A Solid State Phase Transition

Willett, R. D.

J. Chem. Educ. 60,355 (1983)

The thermochromic compound $((\text{C}_2\text{H}_5)_2\text{NH}_2)_2\text{CuCl}_4$, formed when stoichiometric amounts of anhydrous cupric chloride and diethylamine hydrochloride are fused together is recommended for this demo. A Tested Demonstration which would make a good project.

***PHYS ACTIVITY CALORIMETRY DENSITY 2 3**

Solvent-Ion Interactions in Salt Water

A Simple Experiment

Willey, J. D.

J. Chem. Educ. 61,727 (1984)

The temp. and volume changes after the addition of solid NaCl and KCl to deionized water are measured using very simple apparatus. Relationships to ion-water interactions and hydration number are explored.

***PHYS COORD ELECTROANAL PH TITN 4 HAZARD**

The Uranyl-Acetate System Studied by pH Potentiometry

Williams, D. R.

J. Chem. Educ. 48,480 (1971)

Acetate acts as a bidentate ligand in this system. Pye-Ingold titration vessel (air-tight, const. temp.). HAZARD: HClO_4 - storage hazard.

***PHYS ELECTROCHEM IONSELECT KSP 2 3**

The Use of Specific Ion Electrodes for Equilibrium Measurements

Williams, T. R.; Boettner, W.; Wakeham, S.

J. Chem. Educ. 47,464 (1970)

Calibration brings activity correction. Then K_{sp} of CaF_2 , CaCO_3 , etc. determined.

***PHYS ACBA KEQ PH 3**

Molecular Weight Determination of Weak Acids

Wilson, S. A.; Weber, J. H.

J. Chem. Educ. 54,513 (1977)

Uses virial equation for calcn mwts from known K_a and measured pH for mono- and dibasic acids. Exptl data given for tartaric acid; results for other acids. Bibliographers suggest this is an unrealistic expt.

*PHYS PHASE 2 HAZARD

A Eutectic Experiment: For general chemistry laboratory
Wise, J. H.; Shillington, J. K.; Watt, W. J.; Whitaker, R. D.
J. Chem. Educ. 41, 96 (1964)
Biphenyl-naphthalene. Straightforward, one lab period, used in several texts. Hazard: naphthalene is a suspected carcinogen.

*PHYS INORG COMPLEX KEQ 3

Two Student Experiments on Chemical Equilibrium
Wolfenden, J. H.
J. Chem. Educ. 36, 490 (1959)
Practical exam. Titrimetric exp't (student to plan most of experiment) to det'n formula of $\text{Ag}^+ - \text{NH}_3$ complex. Similar, but more difficult, exp't to det'n Ksp of silver acetate.

*PHYS VAPORPRESS 2

Determination of Vapor Pressure
Wolthuis, E.; Brummel, R.; VandenBout, P.
J. Chem. Educ. 36, 494 (1959)
Simple apparatus described for determination of v.p. by a distillation technique.

*PHYS CALORIMETRY THERMO 2

Heat of Reaction and H_2SO_4 Concentration
Wolthuis, E.; Leegwater, A.; VanderPloeg, J.
J. Chem. Educ. 38, 472 (1961)
A pint-sized thermos bottle was used as the calorimeter initially, but later the exp't was performed using a 100-ml beaker insulated by vermiculite, etc. The heat produced by dilution of an unknown H_2SO_4 solution when diluted with H_2O , is used to det'n the conc. of the acid, given a calibration curve that shows the temperature rise when 5 ml std acid is diluted with water.

*PHYS INORG PHASE SOLUB 2

Determination of Solubility: A laboratory experiment
Wolthuis, E.; Pruiksma, A. B.; Heerema, R. P.
J. Chem. Educ. 37, 137 (1960)
Explicit instructions for solubility determination over range 20-100 deg. C by observation of saturation temperatures. Data given for some typical salts. Used at Stony Brook - works well.

*PHYS APPARATUS COLLIG 2 HAZARD

Molecular Weight Determination by Boiling-Point Elevation
Wolthuis, E.; Visser, M.; Oppenhuizen, I.
J. Chem. Educ. 35, 412 (1958)
Simple apparatus used to det. the molecular weight of p-dichlorobenzene, p-dibromobenzene, biphenyl, and naphthalene from the elevation of the boiling point of carbon tetrachloride. The following are HAZARDS (carcinogens): p-dichlorobenzene, naphthalene and carbon tet.

*PHYS PROJ SURFACE 3

Colloidal Surfactants: Suggestions for practical investigations
Wood, J. A.
J. Chem. Educ. 49, 161 (1972)
Critical micelle conc. determined by surface tension, conductance, or spectral changes of a dye. Effect of a third component, temperature, extensions.

*PHYS ORG APPARATUS IR MOLSPECT 4

Infrared Spectroscopic Studies of Hindered Internal Rotation: A physical chemistry experiment
Woodward, A. J.; Jonathan, N.
J. Chem. Educ. 46, 756 (1969)
Low-temp IR. 1,2-dichloroethane, etc. Gas cell, special cell and sample holder: construction given for low temp. liquid and solid.

*PHYS DISTRIB PHASE UVIS 3

Calculation of Activity Coefficients From Spectroscopic Data: A physical chemistry experiment
Worley, J. D.; Fussaro, D. R.
J. Chem. Educ. 45, 534 (1968)
p-Xylene-dodecane- H_2O system. Analysis of aq. layer for p-xylene by measuring absorption at 274 nm.

*PHYS APPARATUS FLASHPHOTOL GAS KIN 4

Recombination of Iodine Via Flash Photolysis: A chemical kinetics experiment in physical chemistry
Yamanashi, B. S.; Nowak, A. V.
J. Chem. Educ. 45, 705 (1968)
Straightforward, but uses special apparatus. 3-4 lab periods.

***PHYS ELECTROCHEM ERROR FASTREACTION IONX KIN 3**

An Amperometric-Kinetic Experiment Emphasizing the Importance of Error Treatment

Young, J. A.; Zeto, R. J.

J. Chem. Educ. 35, 146 (1958)

Study of the hydrolysis of nitroethane. Both pH and current values are recorded. Directions for setting up apparatus (readily available equipment).

***PHYS DEMO DENSITY GAS 2**

Determination of the Molar Volume of a Gas at Standard Temperature and Pressure: A lecture demonstration

Zaborowski, L. M.

J. Chem. Educ. 49, 361 (1972)

A balloon experiment. Best as a demo but could be individual. Simple apparatus.

***PHYS CALORIMETRY THERMO 3 HAZARD**

The Heat of Mixing of Organic Liquids

Zaslow, B.

J. Chem. Educ. 37, 578 (1960)

Calorimetry of CH_3Cl - CCl_4 , CCl_4 -acetone, and CHCl_3 -acetone systems gives info. on hydrogen bond. Dewar flask calorimeter. HAZARD: all systems now suspected carcinogens.

***PHYS ACBA TITN 1**

Laboratory Group Exercises in Acid-Base Theory

Zuehlke, R. W.

J. Chem. Educ. 39, 354 (1962)

Students measure pH of indicator change, use different indicators to find pH of various NaOH/HCl and NaOH/HOAc mixtures. Class results simulate a titration.

***POLYMER PHYS IR PHOTO 4**

Polymer Photooxidation: An Experiment to Demonstrate the Effect of Additives.

Allen, N. S.; McKeller, J. F.

J. Chem. Educ. 56, 273 (1979)

2-Hydroxyl-4-octyloxybenzophenone in commercial polypropylene formulations retards photodegradation. Benzophenone used in this experiment enhances it. Polypropylene powder or chips plus additives is blended in solution or melt, then formed in films by electrically heated press, and exposed to UV. Degradation measured by increase in carbonyl absorption.

***POLYMER PHYS PHOTO VISC 4**

An Introduction to Photoelectrolytes Via the Physical Chemistry Laboratory

Ander, P.

J. Chem. Educ. 56, 481 (1979)

A study of the interaction of sodium polystyrenesulfonate with two conc. of aq. NaCl . Polyelectrolytes are usually coiled in solution. Viscometry is used to determine the change in coiling due to change in counterion conc. Discussion invokes Debye-Huckel and Manning polyelectrolyte theories.

***POLYMER PHYS CATAL PREP VISC 3 HAZARD**

Dependence of Molecular Weight of Polystyrene on Initiator Concentration: An introductory physical chemistry experiment

Ander, P.

J. Chem. Educ. 47, 233 (1970)

Distilled styrene polymerized with varying amounts of benzoyl peroxide.

Viscosity measured, Ostwald or Ubbelohde visc. HAZARD: benzoyl peroxide, sealed tubes.

***POLYMER PHYS DEMO THERMO 4**

Stress-Strain Behavior of Rubber

Arends, C. B.

J. Chem. Educ. 37, 41 (1960)

Some observations on the phenomena surrounding toy balloons as used to explore PVT phenomena. An unusual (photographic) technique is used to study the inflation characteristics of cylindrical balloons.

***POLYMER PHYS THERMO 2 3**

Rubber elasticity -- A Physical Chemistry Experiment

Bader, M.

J. Chem. Educ. 58, 285 (1981)

Elaborates previously suggested demonstrations as a student experiment.

Stress-strain plots at two temperatures lead to polymer theory.

***POLYMER ORG PREP 3**

Acid Hydrolysis of Nylon 66

Berkowitz, W. F.

J. Chem. Educ. 47, 536 (1970)

2 lab periods. Recovery of adipic acid and benzenesulfonate of the diamine. Study questions.

***POLYMER DEMO PREP 2 HAZARD**

Improving the Nylon Rope Trick

Bieber, T. I.

J. Chem. Educ. 56, 409 (1979)

Modification including concentration changes and stirring gives a rope with enough wet strength to resist breaking during the demo.

HAZARD: 1,6-diaminohexane, sebacoyl chloride.

***POLYMER CRYSTAL DEMO MICROSCOPE 1**

Growth and Observation of Spherulites in Polyethylene

Billmeyer, F. W.; Geil, P. H.; VanDerWeg, K. R.

J. Chem. Educ. 37, 460 (1960)

From a science fair project. Polarizing microscope would be most effective for watching the growth of the crystals, observing the extinction patterns, etc., but an ordinary microscope and two pieces of "polaroid" will serve.

***POLYMER COLLOID KIN VACTEK VISC 4**

Polymerization Kinetics and Viscometric Characterization of Polystyrene:

A physical chemistry experiment

Bradbury, J. H.

J. Chem. Educ. 40, 465 (1963)

Vacuum line for purification of monomer and filling dilatometers.

Polymerization rate (by dilatometry) as function of initiator conc.

Viscometry of resultant polymer gives average mol. wt. as function of

initiator conc. Techniques require care. Caution: initiator is in a

benzene solution (carcinogen). Bibliographers are uncertain why the

author describes this experiment as one in "colloid chemistry".

***POLYMER PHYS DEMO PHOTO PHOTORES 2 3**

Polymer Photophysics: A Negative Photoresist

Bramwell, F. P.; Zadjura, R. E.; Stemp, L.; Farenholtz, S. R.

Flowers, J. M.

J. Chem. Educ. 56, 541 (1979)

Photoresist is made by depositing polyvinyl cinnamate from methylene chloride soln on a glass slide, preferably by spin-casting. After placing the object on the slide and exposure to uv, the slide is developed with cellosolve acetate. A simple spin-casting apparatus based on a student centrifuge for ensuring uniformity in the film is described. Polyvinyl cinnamate may be purchased or prepared.

***POLYMER CATAL PREP 3 HAZARD**

Synthesis of Poly(Beta-Alanine) and Beta-Alanine

Carraher, C. E., Jr.

J. Chem. Educ. 55, 668 (1978)

Prep'n of poly(beta-alanine) by treating acrylamide with a catalytic

amount of a solution of metallic sodium in xylene under N₂.

Polymerization is a self (Michael) addition. The product is hydrolysed in acid solution to beta-alanine.

HAZARD: Acrylamide is toxic and sodium dispersions are dangerous.

***POLYMER PREP VISC 4**

Generation of Poly(vinyl Alcohol) and Arrangement of Structural Units.

Carraher, C. E., Jr.

J. Chem. Educ. 55, 473 (1978)

Deacylation of polyvinyl acetate by KOH in methanol to polyvinyl alcohol.

This is then degraded by exposure to periodic acid. Extent of cleavage is followed by viscometry, and measures proportion of 1,2-diol structures.

***POLYMER ORG NAME PREP 3**

Synthesis of Furfuryl Alcohol and Furoic Acid

Carraher, C. E., Jr.

J. Chem. Educ. 55, 269 (1978)

Furfuryl alcohol and furoic acid are prepared from furfural (Cannizzaro).

A ureaformaldehyde resin is prepared as a plywood adhesive using furfuryl alcohol as additive.

***POLYMER ORG NAME PREP 3 HAZARD**

Synthesis of Caprolactam and Nylon 6

Carraher, C. E., Jr.

J. Chem. Educ. 55,51 (1978)

Synthesis of caprolactam from cyclohexone oxime (Beckman rearrangement) and prep'n of Nylon-6 by reaction with catalytic amounts of sodiumhydride + N-actylcaprolactum. See Malmin, J.E., J. Chem. Ed. 57, 752 (1980) for suggestions. HAZARDS: (1) Molten nylon can react explosively with oxygen; (2) lachrymators and skin irritants used; (3) sodium hydride.

***POLYMER CATAL PREP SURFACE 2**

Emulsion Polymerization and Film Formation of Dispersed Polymeric Particles
Ceska, G. W.

J. Chem. Educ. 50,767 (1973)

Sodium lauryl sulfate (surfactant), ammonium persulfate (initiator), styrene and butyl acetate (monomers). Requires N2 sweep, drying oven. Caution: pop bottles are made of flint glass, and are considered hazardous in instructional labs.

***POLYMER STATISTICS 3**

Linear Polymers and Statistics: A Laboratory Experiment
Dole, M.

J. Chem. Educ. 32,202 (1955)

Toy roulette wheel, pegs and numbered tetrahedral balls used to simulate molecular weight distributions.

***POLYMER PHYS DEMO THERMO 2**

Lecture Table Demonstration of Entropy

Dole, M.

J. Chem. Educ. 54,754 (1977)

The classical "thermodynamics of a rubber band" (see Laswick, D.H., J. Chem. Ed. 49,469 (1972)) improved and explained. Simple apparatus.

***POLYMER ORG DEMO HISTORIC 2 3 HAZARD**

An Alternative Procedure for the Nylon Rope Trick

East, G. C.; Hassell, S.

J. Chem. Educ. 60,69 (1983)

Short note recommends and gives method for preparing small amounts of acid chlorides from the dicarboxylic acids and thionyl chloride (rather than starting with the acid chlorides which are storage hazards). DMF catalyzes this rxn. CCl4 solution of the product is poured onto aq. NaOH soln of hexamethylenediamine to yield polymer film at the interface. Note method allows easy prep copolymers. Hazard: CCl4 (susp. carcinogen)

***POLYMER ANAL IR 4**

Determination of Acrylonitrile/Methylmethacrylate Copolymer Composition by Infrared Spectroscopy

Ekpenyong, K. I.; Okonkwo, R. O.

J. Chem. Educ. 60,429 (1983)

Three lab periods, two for prep'n. of copolymer, purif., drying. Quant. anal. based on measurement of nitrile absorption peaks in pellets containing standard amounts of acrylonitrile polymer, by Beers law plots.

***POLYMER APPARATUS COLLIG MEMBRANE OSMOSIS 4 5**

Diffusion and Reverse Osmosis Through Polymer Membranes

Garbarini, G. R.; Eaton, R. F.; Kwei, T. K.; Tobolsky, A. V.

J. Chem. Educ. 48,226 (1971)

Research report. Special diffusion cells, conductance bridge. Evaluation of salt (NaCl) permeation of and/or diffusion through the reverse osmosis membranes Eastman RO-97 and RO-89 (cellulose acetate), and Nylon-6. Detailed introduction.

***POLYMER DEMO PREP 2**

Preparation of a Polymer Latex

Guile, R. L.

J. Chem. Educ. 35, A24 (1958)

A Chem-Ed Tested Demo. Duponol-G + potassium persulfate + sodium metabisulfite. Monomer is styrene. (Duponol-G is a dispersing agent.)

***POLYMER CATAL DEMO 2 3**

Low-Temperature Polymerization: A Laboratory Demonstration

Jenkins, L. T.

J. Chem. Educ. 33,231 (1956)

Vinyl monomers in emulsion polymerization by titanous sulfate-persulfate; can be extended.

***POLYMER DEMO PREP 1**

Rapid Preparation of 6-6 Nylon

Kinsinger, J. B.

J. Chem. Educ. 35, A60 (1958)

Adipyl chloride + hexamethylenediamine. A Chem-Ed Tested Demo. Caution: adipyl chloride is a lachrymator.

***POLYMER APPARATUS CATAL IR ORGANOMETAL VACTEK VISC 4 HAZARD**

Organometallic Catalyzed Synthesis and Characterization of Polyethylene:
An Advanced Laboratory Experiment
Kranbuehl, D. E.; Harris, T. V.; Howe, A. K.; Thompson, D. W.
J. Chem. Educ. 52,261 (1975)
Ziegler-Natta polymerization on vacuum system using organotitanium
chlorides and diethylaluminum chloride. Molecular weight by viscosity,
branching by methyl groups determined by IR on thin films from hot
pressing. Catalysts are commercially available.

***POLYMER ANAL ORG IR PREP 3**

Polymer Preparation in the Laboratory
Lampman, G. M.; Ford, D. W.; Hale, W. R.; Pinkers, A.; Sewell, C. G.
J. Chem. Educ. 56,626 (1979)
Prep. method given for 1) polystyrene foam, 2) cross-linked maleic-
phthalate-based polyester, 3) resilient polyurethane foam, 4) melamine-
formaldehyde laminate, 5) cellulose triacetate (etc.) films. Explicit
procedures. Analysis of films by IR.

***POLYMER APPARATUS PREP 4**

Physical Chemistry of Crosslinked Polysulfide Elastomers
MacKnight, W. J.; Leroi, G. E.; Tobolsky, A. V.
J. Chem. Educ. 42,4 (1965)
Preparation of a 10 percent crosslinked polyethylene tetrasulfide
and stress relaxation measurements (these require stress relaxation
balance - costly, could be made, but no directions).

***POLYMER PREP REVIEW 4 5**

Review of Laboratory Methods for the Preparation of Polymer Films
Mano, E. B.; Durao, L. A.
J. Chem. Educ. 50,228 (1973)
Review with 115 references. Covers preparation on solid and liquid
surfaces, other methods.

***POLYMER COURSE PREP STATISTICS VISC 4**

Evaluation of a Viscosity-Molecular Weight Relationship
An Undergraduate-Graduate Polymer Experiment
Mathias, L. J.
J. Chem. Educ. 60,422 (1983)
A series of experiments: prepn of polymethylmethacrylate, intrinsic
viscosity, light scattering. Whole class data used to calculate Mark-
Houwink relationship using statanal, linear regression. Minimal
procedure but good discussion.

***POLYMER CONSUMERPROD 2 HAZARD**

Nylon 6 - A Simple, Safe Synthesis of a Tough Commercial Polymer
Mathias, L. J.; Vaidya, R. A.; Canterbury, J. B.
J. Chem. Educ. 61,805 (1984)
Simple procedure demonstrates polymerization by prepn. of Nylon-6 from
caprolactam. Reaction initiated by N-acetylcaprolactam and NaH-oil
suspension. All materials are commercially available and inexpensive.
Claimed to be safer than the Nylon rope trick. HAZARDS: Reaction mixture
heated to 200 C in test tube with burner; sodium hydride flammability.
Difficult to believe safer than the merely corrosive rope-trick mix.

***POLYMER ASSOC UVIS 4 5 HAZARD**

Light Scattering by Polymers; Two Experiments for Advanced Undergraduates
Matthews, G. P.
J. Chem. Educ. 61,552 (1984)
Light scattering (546nm) used to investigate the extent of coiling in
polystyrene sol. in toluene and gel-sol transitions in aq. gelatin. The
polystyrene expt. requires commercial light scattering spectrophoto-
meter and sophisticated analysis. HAZARD: Chromic acid cleaning solution.

***POLYMER FREERAD KIN NOPROC PREP RADIOCHEM TRACER 4**

Free Radical Polymerization of Styrene: A radiotracer experiment
Mazza, R. J.
J. Chem. Educ. 52,476 (1975)
Kinetics of styrene polymerization from specific activity of polymer and
initiator (AZBN). C-14 labelled azobis isobutyronitrile prep'n. Liquid
scintillation counter.

***POLYMER PHYS ACBA KIN PREP TITN 3 4**

Kinetics of Condensation Polymerization: Preparation of a Polyester
McCaffery, E. L.
J. Chem. Educ. 46,59 (1969)
Dibasic acid or anhydride and glycol condensation; extent of reaction
followed by amount of water formed and titration.
CAUTION: maleic anhydride (if used) is toxic.

***POLYMER ACBA DEMO PREP 2**

The Nylon Rope Trick: Demonstration of Condensation Polymerization
Morgan, P. W.; Kwolek, S. L.
J. Chem. Educ. 36,182 (1959)
Interfacial polymerization of hexamethylenediamine and dibasic acid
chloride. The first description of a classic demonstration and experiment.
See *POLYMER for subsequent notes and improvements.

***POLYMER PHYS GC KIN 4 HAZARD**

Reactivity Ratios From Copolymerization Kinetics: A quantitative gas-liquid chromatography experiment

Mukatis, W. A.; Ohl, T.

J. Chem. Educ. 49,367 (1972)

Detailed discussion. Copolymerization of styrene with methyl methacrylate; disappearance of each monomer followed. HAZARD: solvents are carcinogens.

***POLYMER PHYS GEOM VISC 4**

Conformation of Macromolecules

Napper, D. H.

J. Chem. Educ. 46,305 (1969)

Viscosity vs. conc. of polystyrene in toluene, cyclohexane, gives data to calculate conformational parameters (all discussed).

***POLYMER DEMO PREP 2**

Phenol Furfural Polymer

Ostrup, G.

J. Chem. Educ. 37, A44 (1960)

Aq. phenol + furfural initiated by HCl. A Chem-Ed Tested Demo.

***POLYMER COURSE 3 5**

Competency Based Modular Experiments in Polymer Science and Technology

Pearce, E. M.; Wright, C. E.; Bordoloi, B. K.

J. Chem. Educ. 57,375 (1980)

15 modular experiments (available from author) would make a lab for a polymer chem course but can also stand alone for individual incorporation into other courses. Shortened version of one module included. Synthesis and kinetics, characterization.

***POLYMER PREP 3 HAZARD**

Preparation of a Polysulfide Rubber

Pettit, G. R.; Pettit, G. R., III

J. Chem. Educ. 55,472 (1978)

Improved procedure for copolymerization of ethylene dichloride with sodium sulfide to yield the elastomer Thiokol A.

HAZARD: Sulfides can react with moisture to yield toxic H₂S.

***POLYMER DEMO PHOTO 2 3**

Lecture Demonstrations of Polymer Structure Using Polarized Light

Rodriguez, F.

J. Chem. Educ. 46,456 (1969)

A demonstration, but could be used as an experiment for one or a pair of students.

***POLYMER PHYS DEMO 3**

A Demonstration of Polymer Crosslinking and Gel Formation Without Heating

Ross, J. H.

J. Chem. Educ. 54,110 (1977)

Conversion of a soluble linear polymer into a cross-linked polymer, an insoluble elastic gel. Linear polymer: GANTREZ AN (a comm. copolymer of maleic anhydride and methyl vinyl ether) cross-linked at the anhydride groups by the addition of the hydroxyl groups of triethanolamine. Explicit directions. A tested demonstration.

***POLYMER ORG DEMO NOPROC 3 HAZARD**

Demonstration of Solvent Differences by Visible Polymer Swelling

Ross, J. H.

J. Chem. Educ. 60,169 (1983)

Polynorbornene commercially available can be used to measure polarity of low polarity solvents. Discussion of solubility parameter. HAZARD: some toxic and carcinogenic solvents are used with little or no warning. Also a disposal problem. Probably could be extended as a demo or expt. with commercially available toy figures that swell in water (JZ).

***POLYMER ORG KIN VACTEK 5**

Polymerization Kinetics: Dead-end Radical Polymerization

Senogles, E.; Woolf, L. A.

J. Chem. Educ. 44,157 (1967)

High vacuum system, thermostatted bath, sealed tubes required for polymerization of lauryl methacrylate. Polymer formed at different times determined by precipitation. See Hill, D. J. T., and O'Donnell, J. H., J. Chem. Educ. 61, 881 (1984) for a simplifying modification.

***POLYMER DISTRIB ENVIRON SEPARATION SOLUB 4**

Separation of Waste Plastics. An experiment in solvent fractionation.

Seymour, R. B.; Stahl, G. A.

J. Chem. Educ. 53,653 (1976)

Method for the separation of polystyrene, polymethyl methacrylate, polyvinyl chloride, polyvinyl acetate and low density polyethylene with common solvents given.

***POLYMER CATAL CONSUMERPROD DEMO FREERAD 2 HAZARD**

The Preparation and Properties of Polybutadiene (Jumping Rubber)
Shakhashiri, B. Z.; Dirreen, G. E.; Williams, L. G.
J. Chem. Educ. 57,738 (1980)
Dramatic demonstration of catalysed free radical polymerization of 1,3-butadiene. Requires special heterogeneous catalyst supplied as part of commercially available "Jumping Rubber Kit" (supplier cited). Article discusses reaction mechanism. HAZARD: all reagents used, especially the catalyst, present EXTREME fire hazards. A Tested Demo.

***POLYMER PHYS OSMOSIS VISC 4**

Polymer Molecular Weight Distribution: An undergraduate physical chemistry experiment
Smith, D. R.; Raymonda, J. W.
J. Chem. Educ. 49,577 (1972)
Polyvinyl alcohol used for viscometry and osmometry. Altered Ubbelohde viscometer (req. glassblowing) and Zim-Meyerson osmometer. Research projects suggested.

***POLYMER ORG PREP 2 3**

Polymer Synthesis in the Undergraduate Organic Laboratory
Sorenson, W. R.
J. Chem. Educ. 42,8 (1965)
Includes polyformaldehyde, a polyurethane, Nylon, a polyphenylene ether, polystyrene, isoprene-styrene copolymer. Caution: lachrymators, etc.

***POLYMER ASSOC CONSUMERPROD STATISTICS 1 2**

The Dependence of Strength in Plastics upon Polymer Chain Length and Chain Orientation: An Experiment Emphasizing Statistical Handling of Data
Spencer, R. D.
J. Chem. Educ. 61,555 (1984)
Very simple experiments illustrate statistical analysis for interpretation of data obtained by manually stretching (cold drawing) strips of polyethylene film (garbage bags) and Parafilm. Requires only paper cutter, ball point pen and ruler. Additional simple expts. in polymer structure at the molecular level. Good qualitative discussion.

***POLYMER PHYS 2 4**

Molecular Motion in Polymers: Mechanical Behavior of Polymers near the Glass-Rubber Transition Temperature
Sperling, L. H.
J. Chem. Educ. 59,942 (1982)
Simple experiment measures percent recovery of rubber as function of temp. Could be adapted to any level.

***POLYMER PHYS DEMO 2 3**

On the Crosslinked Structure of Rubber - Classroom Demonstration or Experiment: A Quantitative Determination by Swelling
Sperling, L. H.; Michael, T. C.
J. Chem. Educ. 59,651 (1982)
Swelling in toluene used to measure length extension of rubber band and to calculate avg. number of chain segments between crosslinks. CAUTION: toluene is toxic.

***POLYMER ORG PREP 3 HAZARD**

Preparation and Crosslinking of an Unsaturated Polyester
An Organic Chemistry Experiment
Stevens, M. P.
J. Chem. Educ. 44,160 (1967)
Polyester from phthalic anhydride, maleic anhydride (HAZARD) and 1,5-pentanediol is prepared, then crosslinked with styrene and catalyst.

***POLYMER PHYS APPARATUS ELECTROOPTIC 4**

Electric Birefringence: A Simple Apparatus for Determining Physical Parameters of Macromolecules and Colloids
Trimm, H. H.; Parslow, K.; Jennings, B. R.
J. Chem. Educ. 61,1114(1984)
Apparatus requires some machining and electronic assembly, a LED, pulse generator, photodiode, amplifier, and an oscilloscope. Field transients are of the order of milliseconds. DNA, polytetrafluoroethylene and mineral oil all give different transient birefringence responses. Some discussion of theory.

***POLYMER ORG TLC 3 4**

A Laboratory Introduction to Polymeric Reagents
Wade, L. G.; Stell, L. M.
J. Chem. Educ. 57,438 (1980)
Oxidation of 9-fluorenone to 9-fluorenone uses polymer-bound CrO₃ (caution). Recycled polymer may be used.

***POLYMER DEMO PREP 1 2**

The Bakelite Demonstration: A Safer Procedure
Wilson, A. S.; Peterson, V. R.
J. Chem. Educ. 55,652 (1978)
Recipe: Formalin + phenol + gl. acetic acid. Modification of classic "Tested Demonstration" (Aluya) procedure. Does not bump.

***POLYMER CLATH CONSUMERPROD GC 2 HAZARD**

Encapsulation of Organic Chemicals within a Starch Matrix
An Undergraduate Laboratory Experiment

Wing, R. E.; Shasha, B. S.
J. Chem. Educ. 60, 247 (1983)

Starch is gelled using 10% NaOH, liquids such as linseed oil, turpentine, and herbicides added, and the gel precipitated by CaCl_2 . An alternative procedure using NaOH and CS_2 to produce cellulose xanthate, then oxidizing with 30% H_2O_2 is a HAZARD (toxicity, flammability, control of oxid. rxn.). Filtering and drying gives a white granular solid. Analysis by gc. Possible explosion HAZARD using common blender.

***POLYMER ORG DEMO PREP 4 HAZARD**

Anionic Polymerization of Vinyl Monomers: A Demonstration
Zilkha, A.; Albeck, M.; Frankel, M.

J. Chem. Educ. 35, 345 (1958)

Anionic polymerization to form polystyrene.

HAZARD: butyllithium, exothermicity.

***POLYMER ORG PREP 4 HAZARD**

Polymerization of Ethylene at Atmospheric Pressure:
A Demonstration Using a "Ziegler" Type Catalyst

Zilkha, A.; Calderon, N.; Rabani, J.; Frankel, M.

J. Chem. Educ. 35, 344 (1958)

Amyllithium (HAZARD) is prepared and used with titanium(IV) chloride to polymerize ethylene under nitrogen.

***RADIOCHEM DECAY IONX 3**

Radiochemical Separation of Thallium from Thorium by Anion Exchange Resin:

A Tl-208 reservoir

Abrao, A.

J. Chem. Educ. 41, 600 (1964)

Thorium chloride bound on strong anion exchange resin. After equilibration, Bi-212 (ThC) is present, decaying (60.5 min half life) to Tl-208. The short half life (3.1 min) daughter can be periodically eluted and decay constant measured.

***RADIOCHEM ANAL CONSUMERPROD ISOTOPE NATPROD PHARM 4 HAZARD**

Isotope Dilution Analysis: Cholesterol in Gallstones and Caffeine in Tea,
Cola and Nodoo

Ault, A.; Kraig, R.

J. Chem. Educ. 46, 767 (1969)

Carbon(14)-labelled cholesterol, caffeine. Liquid scintillation counters.

HAZARD: chloroform and dioxane are suspected carcinogens.

***RADIOCHEM INORG COORD EXCHANGE KIN TRACER 3**

Ligand Exchange Kinetics by the Radioactive Tracer Technique

Barton, D.; Winter, K.

J. Chem. Educ. 43, 93 (1966)

Trans-dichlorobisethylenediaminecobalt(II)chloride is converted to the carbonate complex; then allowed to exchange with C-14 labelled CO_3^{2-} . Rate of exchange followed by counting techniques. Explicit directions.

***RADIOCHEM PHYS UVIS XRAY 4**

The Radiolysis of Air-Saturated Solutions of Iodine: An undergraduate experiment involving an isobestic point

Bibler, N. E.

J. Chem. Educ. 45, 722 (1968)

Gamma-induced $\text{I}_2\text{-CCl}_4$ reaction. Co-60 source or x-ray generator. Recording vis. spectrophotometer. Permits measurement of G values for two simult. reactions. 1 lab period.

***RADIOCHEM INORG COORD CRYSTAL EXCHANGE 3 4**

Isotopic Exchange in Prussian Blue

Bonnette, A. K.; Gandy, S. E.

J. Chem. Educ. 58, 355 (1981)

Use of gamma emitting nuclides Fe-59 and Na-22 to study exchange of $\text{Fe}(+3)$ and $\text{Na}(+)$ in solution with $\text{Fe}(+3)$, $\text{Fe}(+2)$ and interstitial cation sites in Prussian Blue lattice. Single channel gamma spectrometer required. Results related to two proposed Prussian Blue lattice structures. Caution: Iron ferricyanide, poison.

*RADIOCHEM DEMO ELECTROPHOR 4

Separation of Pb-210 from Bi-210 by Low Voltage Electrophoresis: A Radiochemical Separation Experiment
Borke, M. L.; Rangoonwala, N.
J. Chem. Educ. 48,699 (1971)
Radium DEF sol'n (low activity) on cellulose acetate strips, 350v,10 min.
Scan end-window counter, also visualize spots.

*RADIOCHEM ANAL APPARATUS NEUTRON 4 HAZARD

A Californium-252 Neutron Source For Student Use
Bowen, H. J.
J. Chem. Educ. 52,682 (1975)
Design of a nearly uniform source given. Approx. \$100 of special equipment. 5 student neutron activation experiments described (V-52, Ag, Mn in ores, Na in glass, W in complexes). HAZARD: source must be stored and used surrounded by concrete. 1-hr max. exposure.

*RADIOCHEM DEMO SEPARATION 1

Separation of Ce-144 from Pr-144: A radiochemistry demonstration
Bradley, A.; Adamowicz, M.
J. Chem. Educ. 36,136 (1959)
Intended for high schools. Milligram quantities of cerium and praseodymium are separated by filtration of the insoluble iodate of cerium(IV). Explicit directions.

*RADIOCHEM SOLUB TRACER 4

Solubility of Neodymium Oxalate by Coprecipitation with Pm-147
Bradley, A.; Peterson, H. T., Jr.
J. Chem. Educ. 37,398 (1960)
Research report. Pm(147) used as a tracer for Nd. This can be done because the chemical properties of the two lanthanides are very similar.

*RADIOCHEM APPARATUS DEMO IONX 4

Measurement of the Half Life of UX₂(Pa-234) with a Dipping Counter
Braunstein, J.; Young, R. H.
J. Chem. Educ. 38,31 (1961)
Th(234) is separated from uranyl nitrate solution by cation exchange; uranyl is eluted with H₂SO₄ sol'n; Pa(234) formed by decay of the Th(234) on the column is then eluted with HCl. Apparatus given schematically; directions for performing the exp't as a demo are very clear. The demo is suitable for Gen. Chem., but not the experiment itself.

*RADIOCHEM PREP 4

Preparation and Application of Carrier-Free Pb-212 in a Radiochemical Teaching Laboratory.
Broda, E.; Schonfeld, T.
J. Chem. Educ. 54,577 (1977)
Comment on Kvale and Skerestad, J. Chem. Ed. 51, 756 (1974); gives a simple cheap method for the preparation of the tracer. A Chem Ed. Compact.

*RADIOCHEM ORG PHYS EXCHANGE KIN TRACER 3

The Kinetics of an Exchange Reaction Using a Radiochemical Tracer
Brown, G. R.; Winkler, C. A.
J. Chem. Educ. 53,461 (1976)
I-131 half life of 8.15 days. Exchange is: $\text{NaI}^* + \text{nC}_4\text{H}_9\text{I} = \text{NaI} + \text{nC}_4\text{H}_9\text{I}^*$
Requires one 4-hr period. Student directions by writing. B-counter, centrifuge, thermostat.

*RADIOCHEM IONX 4

A Thorium-234 "Cow" for Pa-234
Carswell, D. J.; Lawrance, J. J.
J. Chem. Educ. 36,499 (1959)
Anion exchange - DeAcidite FF; cation exchanger in the overflow circuit. Details of construction of the apparatus given.

*RADIOCHEM DECAY 3

Demonstration of a Parent-Daughter Radioactive Equilibrium Using Cs-137-Ba-137m
Choppin, G. R.; Nealy, C. L.
J. Chem. Educ. 41,598 (1964)
Cs-137 which decays (half life 30 y.) to Ba-137m (half life 2.6 m.) is separated by pptn and filtration of BaSO₄. Ba-137 counted in solid and in solution, allows measurement (well-type scintillation counter) of half life. See also Pinajian, J.J., J. CHEM. EDUC., 44, 212 (1967) for a simple ion exchange separation.

*RADIOCHEM COURSE INTEGR REVIEW 4

Nuclear Experiments in the Chemistry Curriculum
Clark, H. M.
J. Chem. Educ. 47,203 (1970)
Review with 88 references (all checked for inclusion in this file).

***RADIOCHEM DEMO REVIEW 2 4**

Criteria For Experiments in Radiochemistry

Clark, H. M.

J. Chem. Educ. 40, 618 (1963)

Design of experiments and incorporation into undergraduate curriculum described. Not an experiment.

***RADIOCHEM COLUMNC DECAY 4**

A Praseodymium-144 Cow

Cockcroft, W. E.

J. Chem. Educ. 50, 633 (1973)

Ce-144, Pr-144 system. Wet separation via MnO₂ column. Details of construction and preparation given. G-M counter.

***RADIOCHEM ANAL COMPLEX EDTA IONX TRACER UVIS 4**

Determination of Calcium in Sea Water: Analytical Experiment Using the Radionuclide Ca-45

Corless, J. T.

J. Chem. Educ. 42, 421 (1965)

Elution of Ca from Dowex-50 followed by Ca-45 tracer. EDTA endpoint detected spectrophotometrically (Murexide).

***RADIOCHEM DECAY NOPROC 1 2**

Radioisotope Generators for Introductory Laboratory Use

Crater, H. L.; Macchione, J. B.; Gemmill, W. J.; Kramer, H. H.

J. Chem. Educ. 46, 287 (1969)

Inexpensive minigenerators designed for 22 different radiochem experiments, including detector characteristics, statistics of counting, decay, transient equilibria, gamma ray scattering, etc.

***RADIOCHEM AUTORAD CONSUMERPROD 1**

Radioactivity Experiments for High Schools Using Orange Glazed Ceramics

Crawley, H. W.

J. Chem. Educ. 36, 202 (1959)

Uranium glazes in orange pottery have high levels of activity, measured by exposure of x-ray film and by Geiger counter, and compared with radioactive materials.

***RADIOCHEM ANAL NEUTRON 4**

Determination of Copper in Alloys by Fast Neutron Activation

Daly, P. J.; Hofstetter, K. J.

J. Chem. Educ. 44, 412 (1967)

Fast neutron source. GM counter, scaler. 1 lab period. Straightforward.

***RADIOCHEM INTEGR TECHNIQUE 4**

Some Convenient Laboratory Experiments in Radiochemical Techniques

Dillard, C. R.; Morton, L.

J. Chem. Educ. 35, 238 (1958)

Exp'ts which could be included as part of courses in P.Chem, Inorganic or Inst. Anal are outlined.

***RADIOCHEM COMPLEX DECAY DISTRIB TRACER 4**

Growth and Decay: An Experiment Demonstrating Radioactivity

Relationships and Chelate Solvent Extraction Separations

Downey, D. M.; Farnsworth, D. D.; Lee, P. G.

J. Chem. Educ. 61, 259 (1984)

Bi-212 and Pb-212 used as tracers to monitor sepn. of Bi/Pb by solvent extrn. of their dithizone complexes. Growth of Bi-212 (daughter prod. of Pb-212) and decay also measured. Procedure requires: "thorium cow" (prep. described) two GM counters, scintillation detector/multichannel analyzer. CAUTION: CCl₄ is a carcinogen; work in hood.

***RADIOCHEM PHYS DRYLAB 3**

A Rutherford Elastic Scattering "Experiment"

Duggan, J. L.; Yegge, J. F.

J. Chem. Educ. 45, 85 (1968)

Data from Oak Ridge using Cockcroft-Walton accelerator on deuteron scattering from carbon and from nickel can be used to calculate nuclear cross sections.

***RADIOCHEM APPARATUS DEMO 4 HAZARD**

Electrostatic Radionuclide Separation: A New Version of Rutherford's "Thorium Cow"

Eiswirth, M.; Schwankner, R.; Weigel, F.; Wishnevsky, V.

J. Chem. Educ. 59, 608 (1982)

Collection of experiments using the 220-Rn from natural ThO₂: production of alpha tracks in a cloud chamber, isolation of carrier-free 220-Rn daughters, a study of surface charge conditions in absorption precipitation of 212-Pb on freshly precipitated AgCl. HAZARD: high voltage (0.1-1.0 kV).

*RADIOCHEM DECAF 3

Dating of Uranium Minerals by the Specific Radioactivity of Lead
Fairhall, A. W.

J. Chem. Educ. 40, 626 (1963)

Isolation of lead from uraninite minerals and determination of absolute counting rate permits crude determination of age. Counting efficiency measured U-238 Th-234. Two 4 hour labs. Theory in detail.

*RADIOCHEM ORG ISOMERS ISOTOPE 4

Nitration of Benzoic Acid: Determination of Isomer Distribution by the Isotope Dilution Technique

Feldman, M.; Wheeler, J. W.

J. Chem. Educ. 44, 464 (1967)

C-14 benzoic acid nitrated; liq. scintillation counter. Detailed directions.

*RADIOCHEM DISTRIB TRACER 4 HAZARD

Distribution Coefficients and Ionization Constant of H₂AuCl₄: A radioactive tracer method

Forsberg, H. G.; Widell, B.; Ervall, L-G.

J. Chem. Educ. 37, 44 (1960)

Au-198 tracer used to measure distribution of AuCl₃ between water and isopropyl ether. Hazard: Isopropyl ether forms explosive peroxides.

*RADIOCHEM APPARATUS ELECTROCHEM IONX 4

The Self-Absorption of the Beta-Radiation of Ni-63 In Metallic Nickel
Sources: A Demonstration Experiment

Gelsema, W. J.; Donk, L.; VanEnckevort, J. H.; Blijleven, H. A.

J. Chem. Educ. 46, 528 (1969)

Varying thicknesses of Ni-63 deposited electrolytically for end-window counting.

*RADIOCHEM PAPERC 4

A Simple Separation and Identification of Radium D, E, and F

Glasoe, P. K.

J. Chem. Educ. 48, 268 (1971)

Solvent: heavy phase of HCl/n-butyl alcohol mixture. GM counter plus alpha counting if desired.

*RADIOCHEM ORG PHYS EXCHANGE KIN THERMO TRACER 4

The Methanolysis of Substituted Methyl Benzoates: An Exchange Reaction Illustrating Linear Free Energy Relationships

Glover, I. T.; Peterson, C. W.

J. Chem. Educ. 45, 241 (1968)

C-14 methyl esters of subst. benzoic acids prepared from acyl chlorides and C-14 labelled methanol. Requires vac. distn. Rate of exchange with unlabelled CH₃OH followed by measuring rate of disappearance of radioactivity from ester. Scintillation counting.

*RADIOCHEM APPARATUS 4

The Experimental Determination of Thermal Neutron Flux in the Radiochemistry Curriculum

Grant, P. M.

J. Chem. Educ. 54, 707 (1977)

Requires a "teaching" reactor. Measurements use gold as dosimeter.

*RADIOCHEM AUTORAD ENVIRON 0

Junior High School/University Cooperative Experiment: Collection and analysis of fresh nuclear debris

Griffin, J. J.; Driscoll, J. R.

J. Chem. Educ. 50, 438 (1973)

JHS collected nuclear debris (wind-borne) from P.R. China blast of Mar. 18, 1972 using a modified vacuum cleaner. Samples were analyzed at Boston College radiochem lab. Autoradiography procedure given. We hope that opportunities for this experiment will be limited.

*RADIOCHEM APPARATUS AUTORAD ENVIRON 1

A Passive Nuclear Debris Collector

Griffin, J. J.; Stevens, R. L.; Pszeny, A. A. P.; Russell, I. J.

J. Chem. Educ. 56, 475 (1979)

The collector consists of a coffee can with both metal ends removed and its clear plastic top perforated with 80 4-mm holes. A piece of filter paper is cut out to fit in the lid; the can is placed under a drainspout. The filter paper is dried and used for autoradiography. A GM counter and gamma ray spectro. can be used to measure decay rates and energies, and thus identify components.

*RADIOCHEM DECAF NOPROC 3

Nucleonics Experiment: The Half-Life of K-40 by Liquid Scintillation

Grunewald, R.

J. Chem. Educ. 46, 369 (1969)

Short note describes an experiment developed for the nucleonics lab. Activity of a K-40 solution measured with a liq. scintillation counter. No details.

*RADIOCHEM DECAY DEMO EDTA IONX NOPROC 4

Growth and Decay of Radionuclides: A demonstration

Hayes, R. L.; Butler, W. R.

J. Chem. Educ. 37,590 (1960)

An experiment is described where Ba-137m is separated from Cs-137 by an ion-exchange technique in approx. 30 seconds. The ion-exchange apparatus is shown in a diagram. EDTA solutions are used as eluants.

*RADIOCHEM PREP 5 HAZARD

Concentrating Radioactivity

Hermann, R. A.

J. Chem. Educ. 51,420 (1974)

This is not a student experiment. How to get the radioactivity off a radium-dial alarm clock. HAZARD: no one but an experienced technician used to dealing with radioactive materials should perform this operation.

*RADIOCHEM POLYMER CONSUMERPROD VISC 4

Some Properties of Poly(Methyl Methacrylate) Studied by Radiation

Degradation: An Interdisciplinary Student Experiment

Hill, D. J. T.; O'Donnell, J. H.

J. Chem. Educ. 58,174 (1981)

Commercial granular polymers formed by hot pressing, annealed in evacuated glass tubes. Irradiated Co-60 gamma. Students measure change in visc., flex strength, color.

*RADIOCHEM ORG TRACER 3

A Facile Identification of Carbon-14 In Labelled Acetate

An Undergraduate Organic Experiment

Hill, T. B.

J. Chem. Educ. 54,252 (1977)

Designed for large classes. Acetic acid, labelled at C-1 or C-2 is given to students as an unknown. Student reacts HOAc* with anisole in the presence of polyphosphoric acid. Ketone product yields iodoform on hypiodite degradation, which may be filtered and counted. License-exempt quantities. Safety considerations detailed.

*RADIOCHEM TECHNIQUE 4

Solid-State Track Detectors: A novel tool for the study of fission phenomena

Iyer, R. H.

J. Chem. Educ. 49,742 (1972)

Det'n of the U-235 content of natural uranium using the solid state track detector Lexan. Sample is irradiated with thermal neutrons. Only U-235 fissions, leaving tracks. Construction of target apparatus (simple).

*RADIOCHEM ANAL ISOTOPE 4

A Relative Isotope Dilution Analysis Using Samples of Infinite Thickness: For Undergraduate Instrumental Analysis

Johnston, C. B.; Drake, G. W.; Wentworth, W. E.

J. Chem. Educ. 46,284 (1969)

Ca-45 standards plus unknown. Drying oven, counter, special planchet, Clay-Adams pipettor.

*RADIOCHEM DECAY IONX 4

A Demonstration of Rapid Radioactive Decay

Jones, W. H.

J. Chem. Educ. 34,406 (1957)

Decay of a metastable form of Pb-207, half-life 0.8 seconds, followed by scintillation counting. The long-lived parent is radio-bismuth, prepared from ordinary lead by a (p,n) reaction in the 86-inch cyclotron at ORNL. Pb-207m separated from Bi-207 by ion-exchange.

*RADIOCHEM ANAL APPARATUS 4

Photographic Method of Pulse Height Analysis: A laboratory experiment

Jurs, P. C.; Isenhour, T. L.

J. Chem. Educ. 47,719 (1970)

Gamma ray spectra from a sodium iodide scintillator using an oscilloscope and Polaroid camera rather than expensive multichannel analyzer. Photos are taken directly from the screen. Data for Cs-137, Mn-54, etc.

*RADIOCHEM DEMO SURFACE TECHNIQUE 4

Separation of Cesium-137 and Barium-137m by Residue Adsorption

Kirby, H. W.

J. Chem. Educ. 48,269 (1971)

Residue adsorption is based on the principle that any inorganic compound that precipitates at the macroscopic level can be made to adsorb on a non-reactive surface at the trace-level. Differential solubilities of phosphates in NH3, GM or scintillation counter.

*RADIOCHEM ANAL GRAVIM TRACER 4

A Radiometric Method for Sulfate Analysis

Klehr, E. H.

J. Chem. Educ. 49,644 (1972)

Ba-133 tracer. Modification of classic BaSO4 pptn with ppt counted instead of weighed. Scintillation or GM counting.

***RADIOCHEM ANAL NEUTRON 4**

Phosphorus Determination by Derivative Activation Analysis: A Multifaceted Radiochemical Application

Kleppinger, E. W.; Brubaker, E. H.; Young, R. C.; Ehmann, W. D. Yates, S. W.

J. Chem. Educ. 61,262 (1984)

Detailed procedure for quant. analysis of phosphorus by neutron activation analysis of vanadium in a stable phosphovanadomolybdate complex. Requires a small thermal neutron scattering source (CF-252 used), scintillation detector/single channel analyzer.

***RADIOCHEM ANAL STATISTICS 3**

Quantitative Determination of Potassium by Natural Radioactivity
Knudson, G. E.

J. Chem. Educ. 44,694 (1967)

Requires class determination of self-absorption curve and calibration curve. End-window counter.

***RADIOCHEM INORG PHYS CATAL COLOR DEMO VACTEK 4**

Chemical Reactions of Color Centers

Kohn, H. W.

J. Chem. Educ. 42,356 (1965)

Irradiated silica gel. Requires state-of-the-art vacuum and radiation technology, e.g. Van de Graaf generator. Suitable for project.

***RADIOCHEM CHROMATOG DECAY IONX 4**

Radiochemical Study of the Separation of Lanthanum From Barium by Cation Exchanger

Kruger, P.; Coryell, C. D.

J. Chem. Educ. 32,280 (1955)

Genetic study of Ba-140/La-140 and a La-140 reservoir. Parent-daughter separation by ion exchange chromatog. and measurement of both beta and gamma activity. GM counter.

***RADIOCHEM COLUMNC DECAY NOPROC 4**

Preparation and Application of Carrier-Free Pb-212 in a Radiochemical Teaching Laboratory

Kvale, E.; Skarestad, M.

J. Chem. Educ. 51,756 (1974)

From thorium-228 nitrate. Examples of laboratory exercises given, e.g., source preparation for detection and measurement of various radiations. Warning: follow safety regulations for handling of radioactive materials. For a simpler method, see Broda, E.; Schonfeld, T., this file (1977).

***RADIOCHEM ELECTROPHOR ISOTOPE 4**

Birth of an Unique Parent-Daughter Relation: Secular Equilibrium, An experiment in radioisotope techniques

L'Annunziata, M. F.

J. Chem. Educ. 48,700 (1971)

Electrophoretic separation of 90-Sr/90-Y and subsequent observation of ingrowth of 90-Y. Spinco Model R cell. 1 lab period.

***RADIOCHEM ANAL INSTR 4**

A Comparison of 252-Cf and 9-Be(alpha,n) Educational Neutron Sources
Landolt, R. R.

J. Chem. Educ. 59,429 (1982)

Radioanalysis of manganous sulfate by identical irradiation and counting techniques used to compare the title sources. Neutron sources from the Cf source are shown to be more efficient than the PuBe source. This is not an experiment but it could easily be developed into one.

***RADIOCHEM DECAY 3**

Nuclear Isomers Produced by Cobalt-60 Irradiation

Law, J. J.

J. Chem. Educ. 46,49 (1969)

Contact with Co-60 source activates thin foils of Sr, Cd, to metastable isomers. Gamma scintillation counting. Decay rate.

***RADIOCHEM PROJ XRAY 4**

Teaching Moseley's Law: A classroom experiment

Lazzarini, E.; Bettoni, M. M.

J. Chem. Educ. 52,454 (1975)

241-Am and 141-Ce used for gamma irradiation of pure elements and components. X-rays analyzed by Ge-Li counter, multichannel analyzer. Could be used as a class project in a radiochem lab course.

***RADIOCHEM ANAL BIOCHEM GRAVIM ISOTOPE TECHNIQUE 4**

Isotopes in Chemistry Teaching

Libby, W. F.

J. Chem. Educ. 34,578 (1957)

Explicit directions for (1) analysis of a solution for sulfate, both radiochemically and gravimetrically, (2) studying crystal growth, (3) following pptn of basic carbonates, (4) following assimilation of C-14 by growing plants. These exp'ts are designed to teach students how to use a Geiger counter.

***RADIOCHEM DIPOLE KSP SOLUB TRACER 4**

Solubility in Mixed Solvents: A radiochemistry experiment

Lochmuller, C.; Cefola, M.
J. Chem. Educ. 41,604 (1964)

Cobalt mercurithiocyanate solubility in alcohol-water measured using cobalt-60 tracer. Dielectric constant measured or from lit. Log Ksp vs. 1/D is linear, Bjerrum-Fuoss ion pair theory by ref.

***RADIOCHEM TECHNIQUE 4**

Simple Liquid Scintillation Counting of C-14 Labelled *CO2

Loewenberg, J. R.; Grunewald, R.
J. Chem. Educ. 46,171 (1969)

Syringe removes CO2 gas sample, inserts it as slow bubbling through scintillation solution.

***RADIOCHEM ANAL PHYS KSP SOLUB - TRACER 3**

The Solubility of Zinc Oxalate: A physical chemistry experiment

Lyndrup, M. L.; Robinson, E. A.; Spencer, J. N.
J. Chem. Educ. 49,641 (1972)

Tracer experiment. Zn-65. License exempt quantities. Scintillation counter.

***RADIOCHEM ANAL ERROR ISOTOPE 4**

Direct and Reverse Isotope Dilution Analysis: A Simple Experimental Approach Using Volumes.

Marshall, R. A. G.
J. Chem. Educ. 53,320 (1976)

P-32 as phosphate. Liquid G-M tube. Detailed error analysis. Method is for determination of liquid volumes.

***RADIOCHEM ANAL TRACER 4**

Radiometric Analysis of Ammonia in Water

Mehra, M. C.
J. Chem. Educ. 49,837 (1972)

Ag-110 tracer follows release of Ag(+) from insol. silver salt (iodate, tungstate, selenite or phosphate) by dissolved ammonia. Solution scintillation counting.

***RADIOCHEM ANAL ORG GC TRACER 5 HAZARD**

A Radiochemical Experiment in Gas Chromatography

Merrigan, J. A.; Nicholas, J. B.; Rack, E. P.
J. Chem. Educ. 43,543 (1966)

Completely dedicated chromatograph. Special counting cell. Tagged Br2 reacts in gas phase with CCl4 (HAZARD) or hexane to yield a variety of products. Chromatograms are plotted as counting rate vs. time.

***RADIOCHEM ELECTROPHOR 4**

Experiments in Radiochemistry: Paper Electrophoretic Separation of 90-Sr and 90-Y

Miekely, N.; Roldao, L. A.
J. Chem. Educ. 59,432 (1982)

Straightforward, one period. Carrier-free solutions, GM counter.

***RADIOCHEM INORG DRYLAB STOICH 1**

It's Beanium!!

Miller, G. C.
J. Chem. Educ. 58,507 (1981)

Easy concepts of isotopes and isotope mass and atomic weight by using different types of beans.

***RADIOCHEM ANAL ISOTOPE 4**

An Isotopic Dilution Experiment Using Liquid Scintillation: A Simple Two-Sytem, Two-Phase Analysis

Moehs, P. J.; Levine, S.
J. Chem. Educ. 59,675 (1982)

Designed for clinical chemistry and instrumental analysis courses. An ethanol-toluene mixture is analyzed by adding C-14 labelled toluene, extracting the ethanol with water and comparing the specific activity of the resulting toluene with that of a standard. Detailed, with hazard analysis. Requires a liquid scintillation spectrometer.

***RADIOCHEM ANAL IONX TRACER 4**

An Anion Exchange Radiochemical Experiment:

Separation of manganese, zinc, and iron

Morie, G. P.; Sweet, T. R.; Pitstick, G. F.
J. Chem. Educ. 41,389 (1964)

Tartrate complexes of Mn-54, Zn-65, Fe-59 tracers separated on anion exchange resin. Scint. counter.

***RADIOCHEM DEMO IONX TRACER 3**

Ion Exchange on a Natural Clay Mineral: A demonstration experiment

Mucci, J. F.; Hollister, C.; Marshall, L. R.

J. Chem. Educ. 41,602 (1964)

Montmorillonite clay with successive Cs(+) + Cs-137(+), Co(+2), Co(+2) + Co-60(+2), and Cs(+) + Cs-137(+) shows relative binding Cs(+) more than Co(+2), retention volume.

***RADIOCHEM ANAL CHROMATOG IONX TRACER 4**

Ion Exchange-Radiochemical Experiment

Mucci, J. F.; Spiegel, D. E.; Stearns, R. L.

J. Chem. Educ. 38,348 (1961)

Measure total exchange capacity of resin from elution curves. Dowex 50-X2. Chlorides. See later exp't., V.41, 163(1964).

***RADIOCHEM ANAL FLUOR IONX NOPROC XRAY 6**

Energy Dispersive X-ray Fluorescence Analysis in Ion-Exchange Studies

Mucci, J. F.; Stearns, R. L.

J. Chem. Educ. 52,750 (1975)

X-rays from radioactive source (ref. to technique). Lithium-drifted silicon detector signal fed to channel analyzer. Cs+ and Co++ on resin examined quantitatively.

***RADIOCHEM ANAL CHROMATOG IONX TRACER 4**

The Cesium-Cobalt-Dowex 50-X2 System in H+- Form

Mucci, J. F.; Stearns, R. L.; Fleishman, H. F.

J. Chem. Educ. 41,163 (1964)

Elucidation of ion-exchange chrom. process. Scintillation counter with pulse height analyzer. Fraction collector. Dowex-X2, chlorides.

***RADIOCHEM 4**

A Method for the Determination of Half-Lives of Long-Lived Radioisotopes

Muse, L. A.; Saftir, W. J.

J. Chem. Educ. 59,431 (1982)

Short note describes a liquid scintillation counting method which permits calculation of half-life of potassium-40.

***RADIOCHEM DECAY DISTRIB 4 HAZARD**

Method to Determine the Half-Life of K-40

Navarrete, M.

J. Chem. Educ. 46,368 (1969)

Elegant experiment based on measurement of K-40 decay rate and detection efficiencies using Pa-234 from uranyl nitrate. HAZARD: CHCl3 used in purification of uranyl nitrate by cupferron, is a carcinogen.

***RADIOCHEM SURFACE TRACER 4 5**

Measurement of the Specific Surface Area of Lead Sulfate Using Sulfur-35

Nealy, C. L.; Choppin, G. R.

J. Chem. Educ. 41,597 (1964)

Sulfate labelled with S-35 (weak beta emitter) used to prepare PbSO4 solid and determine ratio PbSO4 on solid surface to PbSO4 in solution.

***RADIOCHEM DIFFUSION EXCHANGE NOPROC TRACER 5**

Radio Tracer Studies of Metal-Metal Ion Exchange

Newman, D. S.

J. Chem. Educ. 42,424 (1965)

Research report on tracer zinc, cadmium, silver ion in equilib. with metal surface to measure metal ion exchange and metal diffusion. Suitable for student project work. Requires some glass-blowing.

***RADIOCHEM COURSE TECHNIQUE 4**

Radioisotope Experiments in the Orins Summer Institute Programs

Overman, R. T.; Coffet, D. L.; Muse, L. A.

J. Chem. Educ. 35,296 (1958)

No procedure, or minimal procedures. Outline of techniques taught at the Oak Ridge Institute of Nuclear Studies for science teachers.

***RADIOCHEM DECAY DISTRIB 4 HAZARD**

Three Convenient Laboratory Experiments in Radiochemistry

Parekh, P. P.; Pant, D. R.

J. Chem. Educ. 47,71 (1970)

Sepr'n of daughters of comm. thorium nitrate. GM and gamma scintillation counters. Caution: extractant is diallyldithiocarbamido-hydrazine (carcinogen?), (prep'n ref.). HAZARDS: CHCl3, carcinogen; isopropyl ether forms explosive peroxides.

***RADIOCHEM BIOCHEM IONX UVIS 4**

Iron Metabolism in the Rat: An experiment in biochemistry

Paul, K. G.; Stigbrand, T.

J. Chem. Educ. 47,722 (1970)

Rats injected with iron-59 citrate sacrificed. Hemin isolated from blood, ferritin from liver, myoglobin and cytochrome C from heart or skeletal muscle by extraction, centrifugation, ionx. Assay by uvis; ferritin with sulfosalicylic acid, and by radiochem.

***RADIOCHEM NEUTRON TRACER 2**

A Freshman Experiment in Neutron Activation Analysis

Pickering, M.

J. Chem. Educ. 49,430 (1972)

Det'n of Mn in iron wire. Irradiations are not performed by students. Experiment is safe, but take intelligent precautions. Explicit procedure for sep'n of Mn(*) from Fe+3, using Mn+2 carrier, controlled pH pptn Fe(OH)3; addition of 6% H2O2 ppts MnO2. GM counting.

***RADIOCHEM DISTRIB 4 HAZARD**

Alpha Spectroscopy Using Thorium Daughter Products

Pickering, M.; Davis, R.

J. Chem. Educ. 49,432 (1972)

Straightforward. Carrier-free preparation. Thorium extracted with tributyl phosphate/chloroform. HAZARD: chloroform is a carcinogen.

***RADIOCHEM IONX 4**

A Cesium-137--Barium-137m Isotope Generator

Pinajian, J. J.

J. Chem. Educ. 44,212 (1967)

Ion exchange on special mesh zirconium phosphate separates parent-daughter activities in one hour experiment. Reaction conducted in Pasteur pipet; drops (5-20) collected and counted.

***RADIOCHEM DECAY IONX 4**

Determination of The Half-Life of Thorium-234

Pinnell, R. P.

J. Chem. Educ. 47,459 (1970)

Th-234 obtained from comm. uranyl nitrate and separated from uranium by ion exch. chromatog. as chlorides. Uranium recovered as the ferrocyanide. Activity of Th-234 counted on column, GM.

***RADIOCHEM ANAL ISOTOPE TRACER 2**

A Simple Isotope Dilution Analysis Experiment

Pope, C. G.

J. Chem. Educ. 52,343 (1975)

Linde mol. sieve 13x in solution with the zeolite pellets are analyzed for sodium using Na-22.

***RADIOCHEM ANAL NEUTRON 5**

An Elegant Neutron Activation Analysis: An undergraduate experiment

Rengan, K.

J. Chem. Educ. 55,203 (1978)

Requires activation in a nuclear reactor, and vanadium standard. Vanadium, aluminum, and chromium in non-ferrous alloy. Uses state-of-the-art gamma ray spectroscopy. Li-drifted Ge detector, multichannel analyzer.

***RADIOCHEM IONX NEUTRON 4 HAZARD**

The Chemical Effects of Nuclear Transformation: A simple experiment for a radioisotope course

Rengan, K.

J. Chem. Educ. 57,383 (1980)

Neutron irradiation of potassium chromate produces Cr-51. Ion exchange and gamma ray spectrometer, single channel analyzer used to separate Cr(III) from Cr(VI) and determine percent original Cr(VI) converted to Cr(III). Illustrates Szilard-Chalmers effect. HAZARD: Cr cmpds, suspected carcinogens. Irradiated sample must be "cooled" for two weeks to allow decay of K-42 isotope.

***RADIOCHEM KSP SOLUB TRACER 4**

Radioisotope Demonstration of Common Ion Effect on Solubility

Roig, E.; Rieckehoff, I. G.; Russo, C. S.; Curet, J. D.

J. Chem. Educ. 38,350 (1961)

Effect of common ions on the solubility of TiCl₃ (thallous chloride) followed by labelling Ti+ solution with Ti-204. Explicit directions.

***RADIOCHEM IONX 4**

A Simple Ba-137m - Cs-137 Milking System for Secular Equilibrium Studies

Ruddy, F. H.

J. Chem. Educ. 51,689 (1974)

Prep'n given for thallous phosphotungstate ion-exchanger plus Cs-137 - Ba-137m activity (adsorbed). Elution separates univalent Cs from divalent Ba. Count simultaneously crystal photomultipliers.

***RADIOCHEM ORG PHYS EXCHANGE ISOTOPE KIN 2**

A Kinetics Experiment for First Year Chemistry

Schaefer, W. P.

J. Chem. Educ. 41, 558 (1964)

I-131 exchange with various alkyl iodides in acetonitrile. Counted as liq. or filter paper, GM counter. Assumed 2nd order.

***RADIOCHEM DECAY DISTRIB 4**

A Study of Secular Equilibrium Using Ce-144-Pr-144

Semmelrogge, W. F.; Sicilio, F.

J. Chem. Educ. 42, 427 (1965)

Aqueous Ce-144/Pr-144 mixture extracted by methyl isobutyl ketone (10 drops) after Ce(III)/Ce(IV) conversion by sodium bismuthate. Ce-144 (in organic phase) transferred to a planchet, stabilized with collodion, dried under a heat lamp and counted. Saturation activity of Ce144+Pr-144, Pr-144 decay, and Ce-144 activity from plot of total activity of initially pure Ce-144. Gamma spec. or filter helps to count only Pr-144. Other solvents suggested.

***RADIOCHEM ANAL EXPLOSION GRAVIM TECHNIQUE TRACER 4 HAZARD**

Radiochemical Investigation of Some Sample Destruction Procedures.

Servant, D. M.

J. Chem. Educ. 51, 550 (1974)

Ag-110 used to evaluate ashing of AgX in strip film. Well-type scint. counter. One method is a HAZARD: hot HClO₄/HNO₃ + organic material is an explosion hazard.

***RADIOCHEM PHYS KSP TRACER 4**

The Solubility of Thallium(I) Bromide: A radiochemistry experiment

Sheppard, J. C.; Jensen, R. C.

J. Chem. Educ. 40, 34 (1963)

TlBr solubility determined using microcurie amnts of Tl-204. Const. temp. bath; end-window Geiger counter. Complete directions given and suggestions for further investigations. Caution: Thallium compounds toxic.

***RADIOCHEM PHYS DISTRIB TRACER 4**

Extraction of Cobalt(II) Complexes: A radiochemistry experiment

Sheppard, J. C.; Jensen, R. C.

J. Chem. Educ. 40, 33 (1963)

Distribution of Co(II) triaryl amine complexes between xylene and dil. HCl. Measured using Co-60 tracer. Well-type scintillation counter. Studies effect of conc. and pH.

***RADIOCHEM DECAY DISTRIB IONX NOPROC REDOX 4**

Some Chemical Properties of Neptunium: A radiochemistry experiment

Sheppard, J. C.; Jensen, R. C.

J. Chem. Educ. 40, 35 (1963)

Np-239 (by neutron activation of U-238) is not an alpha emitter. Separated fission products by ion exchange or solvent extraction. Redox chemistry, decay constant can be studied.

***RADIOCHEM DECAY 2**

A Half-Life Experiment for General Chemistry Students

Smith, W. T.; Wood, J. H.

J. Chem. Educ. 36, 492 (1959)

Measurement of the half-life of Bi-210.

***RADIOCHEM DECAY 4**

Using The Decay of Ba-137 to Determine Resolving Time in G-M Counting

Stearns, R. L.; Mucci, J. F.

J. Chem. Educ. 38, 29 (1961)

Counting rate as function of time is used. Sample by absorption of Ba-137 on BaCO₃.

***RADIOCHEM DISTRIB EXCHANGE ISOTOPE KEQ 3 HAZARD**

An Elementary Experiment Involving The Symmetry Number Concept

Tolpin, E. I.

J. Chem. Educ. 47, 717 (1970)

Det'n of Keq for (I-131)⁻ + I₂ = I⁻ + (I-131)-I. Corrects the theory of Williams, R.R., et al. J. Chem. Educ. 26, 214(1949). HAZARD: CCl₄ is carcinogen, use a substitute.

***RADIOCHEM ANAL AUTORAD OPTICAL PAPERC SEPARATION TRACER 2**

Demonstration of Radioautography and Paper Chromatography Using a Polaroid Camera

Towne, J. C.; Gatti, B. M.

J. Chem. Educ. 40, 243 (1963)

Separation of two C-14 labeled amino acids.

*RADIOCHEM DECAY NEUTRON PROJ 3

Neutron Activation Experiments in Radiochemistry
Vorres, K. S.

J. Chem. Educ. 37,391 (1960)

Extensive description of neutron activation with experimental results with different neutron sources. Provides material for projects or instructor designed experiments.

*RADIOCHEM COMPLEX DECAY DISTRIB 4

A New Method of Separating Pb-210 from Ra-DEF for a Radioactive Equilibrium Experiment

Wai, C. M.; Lo, J. M.

J. Chem. Educ. 61,257 (1984)

The secular equilibrium between Pb-210 and Bi-210 is studied. Diethyl dithiocarbamate is used to complex and extract Bi. Requires 1 microcurie of Ra-DEF (commercial) and a GM counter. CAUTION: CHCl₃ solvent is a carcinogen;use fume hood.

*RADIOCHEM ORG PHYS APPARATUS GC 4 5

Radioactive Bromine Labeling Via Gas Chromatography

Wechter, M. A.; Schmidt-Bleek, F.

J. Chem. Educ. 45,150 (1968)

After thermal neutron irradiation of 1,2-dibromoethane (No details), the inorganic Br-82 is deposited on a short firebrick column. The Br-82 exchanges with alkyl halides introduced in the carrier gas that passes to an analyzing column and G-M, proportional or NaI detector. Isopropyl halides/isopropanol combinations injected into the reactor. Products analyzed by radioactivity and elution time. Exchange rates and bond dissociation energies measured.

*RADIOCHEM ANAL BIOCHEM ISOTOPE TECHNIQUE 4

Substoichiometry and Saturation Analysis

Willett, J. E.; Servant, D. M.

J. Chem. Educ. 54,452 (1977)

Isotope dilution analysis modified by using equal substoichiometric amounts of precipitant. Determination of silver in photographic film and of human placental lactogen in serum. Scintillation counter.

*RADIOCHEM ORG FRIEDEL.CRAFTS NOPROC PREP PROJ TRACER 3 HAZARD

An Undergraduate Organic Experiment With Carbon-14

Wright, J. C.

J. Chem. Educ. 40,206 (1963)

Student is issued a small quant. labelled NaOAc in HOAc at equilibrium. To determine if label is C-1 or C-2, the acid is converted to an acyl chloride and used in Friedel-Crafts acylation of benzene to produce acetophenone, then converted to CHI₃ and counted. Acetophenone also oxidized to benzoic acid and counted. This was a seminal publication, but see newer exp'ts to avoid benzene. HAZARD: benzene, carcinogen.